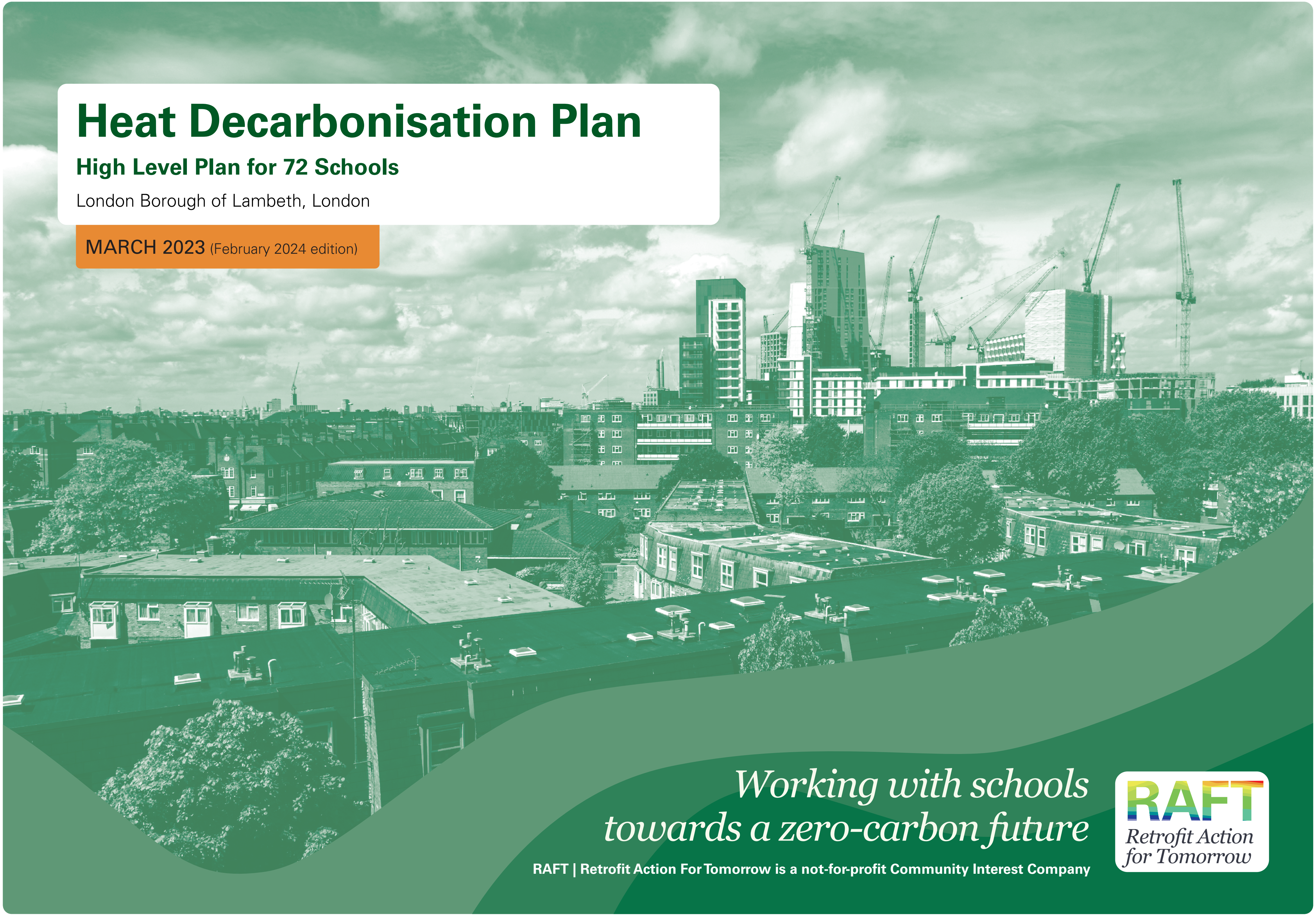


Heat Decarbonisation Plan

High Level Plan for 72 Schools

London Borough of Lambeth, London

MARCH 2023 (February 2024 edition)

Working with schools towards a zero-carbon future

RAFT | Retrofit Action For Tomorrow is a not-for-profit Community Interest Company

RAFT Retrofit Action for Tomorrow

RAFT's Mission

RAFT is an architect-led, multi-disciplinary team with **expertise in deep building retrofit**, **community engagement**, and **zero carbon planning**.

RAFT's mission is to respond to the **climate emergency** by providing education and retrofit advice to schools and surrounding local communities, resulting in **energy and emissions reductions**, resource efficiency and **climate resilience**.

RAFT is a **non-profit CIC** (community interest company), set up to ensure we are **fully aligned with councils, schools and communities** in their climate action, goals and outcomes. We believe that operating as a social enterprise will help schools to have **trust and confidence in RAFT planned outcomes**, as in this report, and thus overcome some of the known barriers to action.

RAFT's Vision for the Future

RAFT is committed to **zero carbon, energy efficient, healthy and climate resilient schools**, with **deeply-engaged communities** leading the way in a fair and just transition of society.

RAFT aims to support the delivery of well-performing buildings, biodiverse landscapes, waste and resource efficiency, wide opportunities for green jobs, careers and local supply-chains and emissions-free local economic growth.

RAFT
Retrofit Action for Tomorrow

"We're going to have to learn together, how to achieve this, ensuring none are left behind. We must use this opportunity to create a more equal world and our motivation should not be fear, but hope"

David Attenborough, 2020

HDP ISSUES

Rev	Reason	Date
P01	DRAFT issue to Lambeth (Giuseppe Ciraolo)	02/03/23
P02	DRAFT issue to Lambeth	28/03/23
P03	Issue to Lambeth & SALIX	31/03/23
P04	Issue to Lambeth - for publication	21/11/23
P05	PSDS funded works tables updated	05/02/24

Contents

Executive Summary

Introduction

In June 2022, RAFT were appointed to write a high-level heat decarbonisation plan (HDP) for Lambeth Council for their school estate. The study was funded by SALIX through the Low Carbon Skills Fund.

Lambeth Council have an aspiration to be zero carbon by 2030. The purpose of this report is to examine the existing state of Lambeth's school estate and to identify what measures are required for Lambeth's schools to be compatible with zero carbon. This report is not a commitment to achieve zero carbon across all the schools, nor does it identify time-frames for rolling out the measures required to meet the zero carbon ambition.

The HDP was completed in March 2023 and is based on data provided to RAFT from September 2022 to early March 2023. Site surveys were not undertaken - all information about the schools and their buildings comes from a range of sources including national CDC surveys and Lambeth condition surveys. Consequently, detailed site surveys of each school will be necessary to validate the high-level outputs of this report. A full list of information sources is provided in the Appendix.

November 2023

Executive Summary

Context

There are 72 schools comprising 231 buildings within this high level heat decarbonisation plan (HDP). They serve approximately 25,000 students at nursery, primary and secondary school level. All schools are maintained schools located in the London Borough of Lambeth.

The schools' buildings date from 1820 to 2022. Six schools have listed buildings and 12 are in conservation areas. 50 schools have DEC ratings and none achieve band A. All but one school have gas boilers, 15 of which are at end of life (across 11 schools). 21 schools have ASHPs in addition to boilers. 30 schools have solar PVs.

Whole estate solution

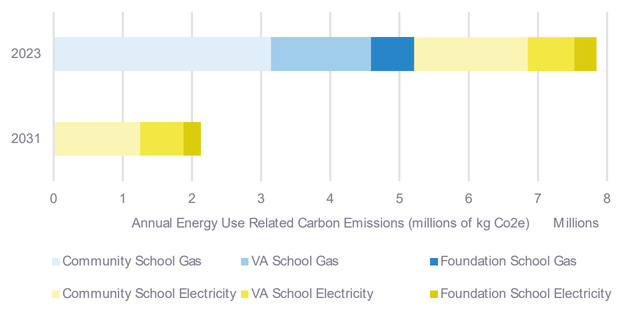
The aim is to decarbonise heat and for **all 72 schools to be net-zero by 2030**, in line with Lambeth council's zero carbon target. This means reducing energy consumption and peak loads, removing all gas boilers and installing PV on all applicable school roofs.

To achieve this each school must apply some or all of the measures noted in the table opposite using a whole-building approach to retrofit. These are rolled out across the estate over seven years, with priority given to schools with planned ASHPs or maintenance works and high emissions or energy use intensity (EUI).

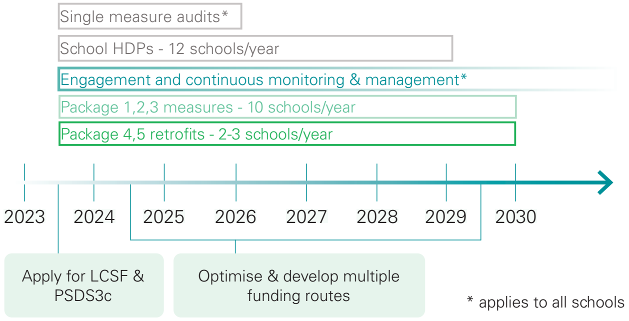
Measures considered for each school

Category	Measure	Package
STAND-ALONE MEASURES (suject to roof condition for PV)	**Energy management & monitoring**	Package 1 measures
	Energy monitoring & display with submetering	
	Air quality monitoring & display	
	Gas & electrical systems management	
	Electricity demand reduction	
	Ensure all lighting is LEDs & install PIRs/timers	
	On-site electricity generation	
	Install solar PV on roofs	
CONSIDER MEASURES HOLISTICALLY	**Fabric & ventilation measures**	
	Good maintenance & draughtproofing	
	Immediate: insulate uninsulated cavity walls & roofs, replace single glazing with triple glazing	2
	Deeper airtightness improvements	4&5
	If required: insulate all walls & roofs (not floors), replace all glazing with triple glazing	
	Mechanical ventilation with heat recovery	
ALONGSIDE LOAD REDUCTION	**On-site gas removal**	Package 3
	Replace gas boilers with ASHPs/GSHPs	
	Upgrade heating pipes and emitters (radiators)	
	Replace gas-fired central hot water storage & distribution with electric point of use hot water	
	Replace gas hobs/ovens with electric	

Reduction in carbon emissions



Decarbonisation timeline



Outcome of proposed decarbonisation projects

	Gas kWh/yr	Electricity kWh/yr	Median EUI kWh/m²/yr	Operational carbon tCO_2e/yr	% tCO_2e saved / yr	Operational costs £/yr	Capital costs (project) £
Existing (2023)	25,740,000	10,500,000	151	8,500	-	£5.9m	-
Once all schools are net-zero-compatible (2030)	0	15,100,000	65	2,100	80%	£4.6m	£235m

1.0 Introduction

This section sets out the London Borough of Lambeth's strategic vision and the definition of ***'net-zero'*** adopted as a long-term ambition for all of Lambeth's maintained schools. It also outlines RAFT's data collection, analysis and modelling used to plan and track the schools' path to zero carbon.

Children in their newly retrofitted classroom

"The UK requires the education sector to play its role in positively responding to climate change and inspiring action on an international stage"

Department for Education, Sustainability and climate change: a strategy for the education and children's services systems, 2022

1.01 What is a heat decarbonisation plan?

Introduction

This report was commissioned by the London Borough of Lambeth upon receiving funding from the Low Carbon Skills Fund (LCSF3) in September 2022 to prepare a high-level heat decarbonisation plan (HDP) for the council's entire school estate. The information in this report is based on data received from Lambeth council, the schools and public sources between September 2022 and March 2023.

Purpose

This report is for Lambeth council and their 72 maintained schools. Its purpose is to:

- provide a clear aim for every school aligned with Lambeth's 2030 zero carbon target
- provide analysis of the existing school estate and the scale of retrofit and maintenance measures needed
- provide a costed programme for delivering a pan estate solution and net zero by 2030
- provide trackers for measuring progress
- provide a list of immediate next steps

Key Metrics

The key metrics for measuring decarbonisation are the reduction in annual operational energy use intensity (EUI - kWh/m^2.yr) and carbon emissions (kgCO_2e/yr) as well as annual energy costs and upfront retrofit costs (£).

Limitations of this report

This HDP is based on desktop analysis of information from multiple sources. Whilst great care has been taken to source accurate information, site analysis and in-depth study of individual schools and buildings is required before any of the measures proposed can be implemented.

In addition, as further information is gathered from site investigations, the data underpinning this HDP's analysis should be updated to provide more accurate energy, carbon and cost estimates.

Feasibility Studies

In tandem with this HDP, pilot feasibility studies for LED lighting, photovoltaics (PV) and air source heat pumps (ASHPs) have been carried out at two schools: Herbert Morrison School and Triangle Nursery School. These are provided as supporting information.

Looking forward

RAFT acknowledges that achieving zero carbon presents a significant challenge and requires efforts from many parties to succeed. This report is a step on the council's zero carbon journey for its school estate and RAFT hopes to further support the council and the wider community over the coming years.

What is a heat decarbonisation plan?

An HDP is an action plan for organisations to reduce their reliance on fossil fuelled heating systems through fabric improvements and by replacing their existing heating systems with low carbon alternatives such as heat pumps, electric heating or local district heat networks.

Organisations keen to reduce the greenhouse gas (GHG) emissions of their buildings will benefit from a focused HDP, which aligns with national and local targets. An HDP can also help an organisation meet its zero carbon ambitions.

All HDPs will at the very least:

- have an understanding of the existing buildings
- have an understanding of existing services systems
- outline current energy use and CO_2e emissions
- adopt a whole building approach
- include an evaluation of the organisation's resource and delivery capacity, budgets and available electrical capacity
- have an evaluation of all available low carbon heating opportunities

This summary is based on Salix's guidance: *Phase 3 Public Sector Low Carbon Skills Fund: Guidance on the preparation of heat decarbonisation plans*, May 2022.

See Appendix for Salix QA mapping to RAFT HDP

Note: This plan is being developed in parallel with a high level HDP for Southwark Diocesan Board of Education (SDBE). The Council wished for a comprehensive plan for all maintained schools, including the 13 CofE VA schools in Lambeth. Given SDBE's parallel LCSF3-funded plan, inclusion of those schools here is not funded by the Council's LCSF3 grant. They are included here on a value added basis, at no additional cost.

1.02 What is a net-zero school?

Net-zero schools

HDPs primarily focus on heat decarbonisation. However, both Lambeth council and national policy are seeking to achieve 'zero carbon schools' (see *1.05 The policy context*). Unfortunately there is no clear UK definition of what that means for existing buildings.

Fundamentally, a zero carbon school has all its energy needs met by on or off-site renewables. It must use no fossil fuels, minimise its energy consumption and maximise on-site renewables.

Using no fossil fuels means **removing all gas boilers (and oil/solid fuel) from schools**. By necessity peak heat loads must be reduced, so that sufficient heat can be provided to buildings using lower-temperature heating systems.

What constitutes 'minimal energy consumption' and 'maximum on-site renewable energy generation'? The extent of off-site renewable energy that will be available for buildings in the future is uncertain so one must determine what might constitute a reasonable 'budget'.

The WLCN-LETI[1] definition of 'Net Zero Carbon (NZC) - Operations Energy' assets, targets an Energy Use Intensity (EUI) of 65 kWh/m^2.yr for new school buildings (LETI, 2021). This target comes from bottom-up analysis of what is practically achievable alongside top-down analysis of future renewable electricity capacity. It also aligns with the RIBA 2030 challenge.

The Department for Education (DfE) is seeking 'zero carbon' for all schools - with an EUI target of 52kWh/m^2.yr for new buildings and energy reductions for existing buildings ranging from 3% (for lifts) to 30% (for heating). (DfE, 2022b)

RAFT recognises that in existing buildings it is hard to achieve the new-build EUI targets. However, it is useful to have a pragmatic EUI target as an absolute measure against which all upgraded schools can be compared. Our energy modelling of over 20 schools has determined that an **EUI target of 75kWh/m^2.yr is achievable in most existing school buildings.** This is achieved through a combination of reducing electricity demand, simple fabric measures, introducing ventilation with heat recovery and replacing gas boilers with heat pumps. Peak heat loads should also be reduced to ensure sufficient heat can be provided.

With regard to renewable energy generation, in urban areas, photovoltaic (PV) panels on roofs are the only real option. The extent of available roof space varies enormously but RAFT's analysis of over 20 primary schools suggests that **at least 10% of roof area can typically be covered by PV panels**.

With these considerations in mind, **this HDP proposes a net-zero target for every school to aspire to**. See box above right.

Net-zero school targets

1. **Energy Use Intensity**
   Reduce EUI to <75kWh/m^2.yr
2. **No on-site fossil fuels**
   Remove all gas/oil/solid fuel boilers
3. **Photovoltaic panels**
   Photovoltaic (PV) panels to cover at least 10% of roof area

Key principles

Radical improvements in energy efficiency
Reducing energy consumption by 80% and reducing the load on the electrical grid is possible and will be required to move away from fossil fuels.

Fossil fuel free heating and hot water
No gas heating or combustion on site. For most buildings this will mean changing to heat pumps. This also improves local air quality.

Ready for future electric grid
Buildings should be upgraded to be ready for a flexible electricity grid by managing their demand; for example by being energy efficient, heating out of hours and having energy storage.

Generate renewable energy
This will be by maximising the amount of solar photovoltaic (PV) installed.

In use energy monitoring and feedback
Continuous review and analysis of energy monitoring. Reporting and sharing data to record energy and carbon emissions and learning from completed projects.

1 **WLCN**: Whole Life Carbon Network
2 **LETI**: Low Energy Transformation Initiative

1.03 Benefits of heat decarbonisation

Minimise fuel costs

Reducing the energy consumption reduces school fuel bills and makes schools more resilient to future changes in fuel prices. In the last 10 years the cost of gas has increased by 84% and electricity by over 45% per unit in real terms (BEIS, 2022).

Improve attention and educational attainment

Recent research has shown the connection between high levels of CO_2 in classrooms with headaches, drowsiness and lower concentration levels. Noise, overheating and inadequate daylight, also have detrimental effects on children's cognitive performance.

Reduce carbon emissions

Nearly 50% of the school's carbon emissions come from burning natural gas or other fossil fuels on site for heating and hot water. Deep retrofit of the school will make the building more thermally efficient and suitable for low temperature and low carbon electric heating provided by, for example, an air source heat pump.

Improve health

Improving ventilation to classrooms by using a mechanical ventilation system improves indoor air quality, reduces the risk of transmission of air borne diseases and reduces indoor CO_2 and other pollutant levels. Good ventilation will also reduce condensation risk and increase the longevity of internal finishes and window products.

Improve comfort

Improving insulation, airtightness and window performance improves internal comfort by increasing internal surface temperatures during winter, reducing "temperature asymmetry" and cold draughts. Introducing MVHR ensures a constant supply of fresh air at a given temperature.

Become an example of a low carbon future in the community

Schools are at the heart of the local community and have a strong role to play in just transition in a low carbon future. A low carbon, climate resilient school with climate leadership can build wider knowledge and understanding, prioritise local communities and climate justice, demonstrate how towns and cities can become, and empower climate action. The ripple effect can lead to community-wide transformation to a cleaner, greener and safer future that is also healthier and fairer.

1.04 RAFT's approach

Our engagement with schools

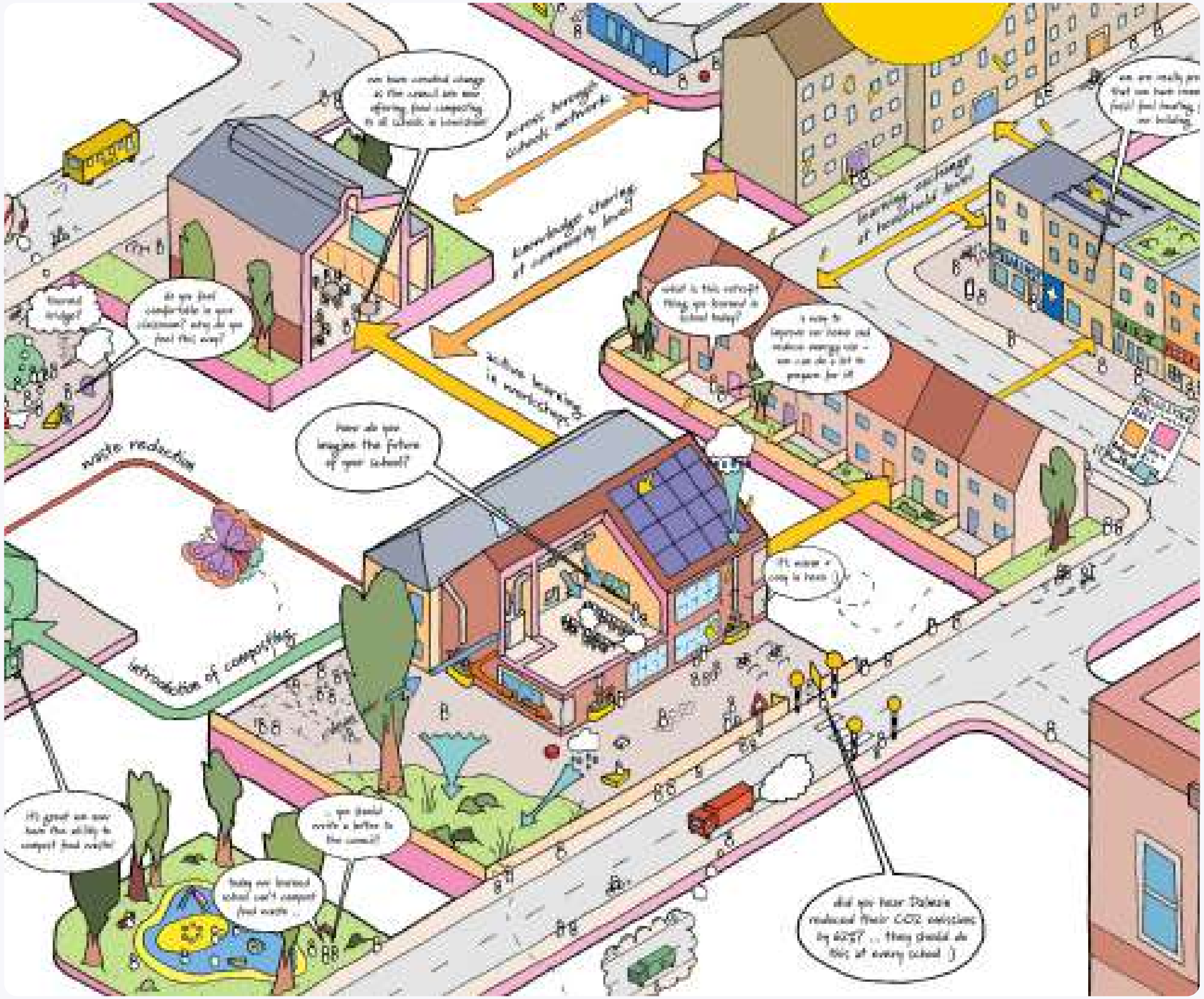
RAFT's unique approach is to combine expert retrofit and decarbonisation advice with school and community engagement and education.

The latter is critical to the process for two reasons. Firstly, to ensure a school can manage and monitor its buildings' energy performance effectively to achieve maximum energy efficiency. Secondly, because of the school's position at the heart of the local community.

RAFT has demonstrated that genuine social engagement in community retrofit projects can create a ripple-effect, leading to greater aspiration for domestic and other retrofit projects more widely across the UK. Schools can become exemplar projects, leading the local community to a net zero carbon future.

The RAFT process includes:

- Extensive engagement with the school and local community
- Detailed carbon and energy audit
- Detailed assessment of existing school buildings
- Appraisal of different retrofit options
- Preparation of phased retrofit plan



The ripple-effect beyond the school

1.05 The policy context

The national policy context

The UK has legally abiding targets to reduce its overall GHG emissions by 78% by 2035 and become Net Zero Carbon by 2050.

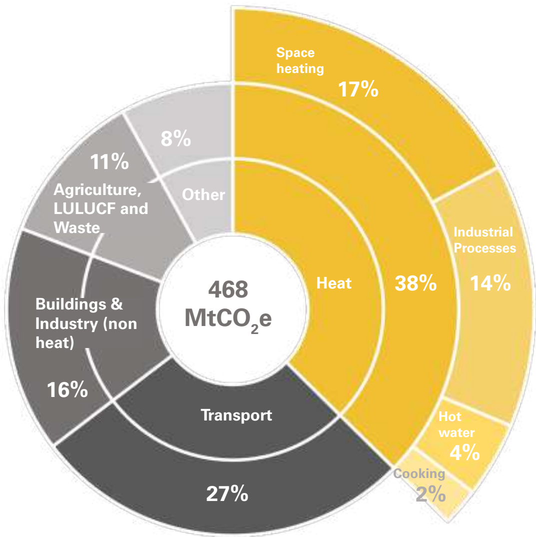
Emissions from heat are the single largest contributor to the overall UK Green House Gas (GHG) emissions. Nearly 38% of the total UK emissions are from activities related to producing heat out of which 17% is from buildings space heating and cooling demand. See chart right.

According to research carried out by Trades Union Congress, the nearly 26,000 government funded schools in the UK comprise half of public sector buildings and emit 4.1 million tonnes of CO_2e. They will need £13.5bn in investment to bring the entire stock to net zero over the next decade. (TUC, 2022)

The UK government's *Heat & Buildings Strategy* (BEIS, 2021) aims to reduce emissions from public sector buildings by 75% by 2037 compared to a 2017 baseline. In addition, the government aims to phase out the installation of gas boilers by 2035. The Public Sector Decarbonisation Scheme (PSDS) run by Salix, supports this ambition.

As noted under section 1.02 above, the DfE aims for all existing schools to become 'zero carbon' and targets certain energy reductions.

UK emissions across sectors in 2016



UK GHG emissions chart (BEIS 2021) - heat accounts for 38% of UK GHG emissions

> *"In April 2021, we enshrined an ambitious target to reduce emissions by 78% by 2035 on 1990 levels into UK law. We must intensify our efforts and eliminate virtually all emissions arising from heating, cooling and energy use in our buildings."*
>
> HM Government: Heat and Buildings Strategy, 2021

Both local and national policy require schools to become 'zero carbon' by 2030 and 2050 respectively.

The local policy context

Lambeth Council recognises the climate emergency and the necessity of a strong, visible response to it. In 2019, Lambeth was the first London borough to declare a climate and ecological emergency and committed to make its estate zero carbon in operation by 2030.

In 2020, Lambeth Council published its Corporate Carbon Reduction Plan "*Becoming a Net Zero Council by 2030 Action Plan*", a detailed action plan encouraging rapid transition. A key point of the plan is to retrofit public buildings to improve energy efficiency through the RE:FIT programme. (Lambeth, 2020)

Nearly 70% of Lambeth's borough-wide emissions are from buildings (Lambeth 2020). According to a study completed by Carbon Trust, **schools make up approximately 40% of all heating-related emissions** of all council owned non-domestic building stock, and are thus significant to achieving decarbonisation. (Carbon Trust, 2022)

1.06 The organisation

Lambeth school estate

The London Borough of Lambeth (LBL) is located in south London. There are 106 schools in Lambeth, of which 72 maintained schools are addressed in this HDP.

- 72 schools, 231 buildings
- School types: 56 primary, 5 secondary, 5 nurseries, 5 special, 1 all-through
- Governance types: 41 community, 23 voluntary aided, 8 foundation
- Heritage: 6 schools with listed buildings, 12 schools in conservation areas
- Building ages: range from 1820-2022
- Heating systems: gas boilers in all but one school, some supplementary ASHPs, solar thermal and heat networks. 11 schools with end-of-life boilers
- Maintenance funding shortfall of £43m. Scheduled maintenance works in 19 schools. Further maintenance needs identified but not funded in 35 schools.
- PSDS3 funding for 6 schools and PSDS applications for a further 9 schools

Total energy usage/costs & CO_2e emissions

Fuel Type	kWh/yr	tCO_2e	Energy costs
Gas	26,000,000	5,500	£2.8m/yr
Electricity	10,500,000	3,000	£3.2m/yr
Total	**36,500,000**	**8,500**	**£6m/yr**

See Section 2 for more information

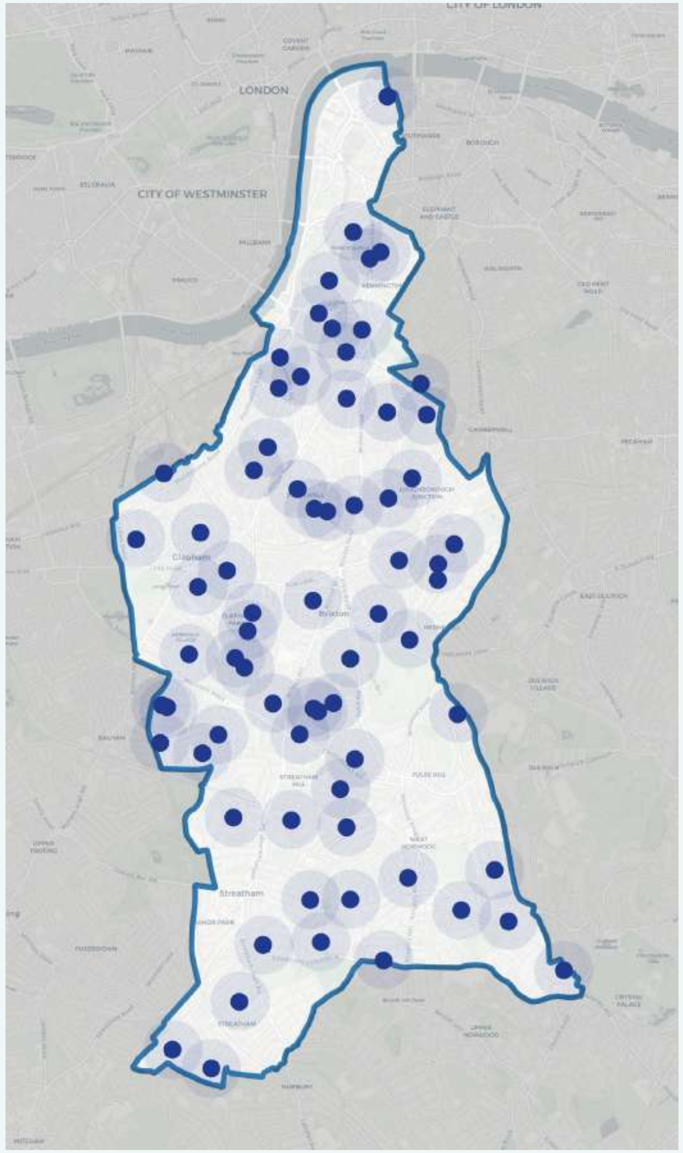
Community Schools
Allen Edwards Primary
Ashmole Primary
Bonneville Primary
Clapham Manor Primary
Crown Lane Primary
Effra Early Years
Elm Court School
Elm Wood Primary
Ethelred Nursery School
Fenstanton Primary
Glenbrook Primary
Granton Primary
Heathbrook Primary
Henry Cavendish Primary (Balham)
Henry Cavendish Primary (Streatham)
Henry Fawcett Primary
Herbert Morrison Primary
Hill Mead Primary
Hitherfield Primary
Holmewood Nursery
Jessop Primary
Jubilee Primary
Kings Avenue Primary
Kingswood Primary (Lower)
Kingswood Primary (Upper)
Lansdowne School
Larkhall Primary Campus
Livity School
Loughborough Primary
Maytree Nursery
Norwood School
Paxton Primary
Richard Atkins Primary
Stockwell Primary
Streatham Wells Primary
Sudbourne Primary
Sunnyhill Primary
Telferscot Primary
The Michael Tippett School
Triangle Nursery
Walnut Tree Walk Primary
Woodmansterne School

Foundation schools
Julian's Primary (Streatham)
Julian's Primary (West Norwood)
London Nautical School
Reay Primary
Turney School
Vauxhall Primary
Wyvil Primary

Voluntary aided schools
Archbishop Sumner CE Primary
Christ Church Primary SW9
Holy Trinity CE Primary
Immanuel & St Andrew CE Primary
Iqra Primary
Macaulay CE Primary
Orchard Primary
St. Andrew's CE Primary
St. Andrew's RC Primary
St. Anne's RC Primary
St. Bede's Catholic Infants
St. Bernadette Catholic Junior
St. Helen's RC Primary
St. John the Divine CE Primary
St. John's (Angell Town) CE Primary
St. Jude's CE Primary
St. Mark's CE Primary
St. Mary's RC Primary
St. Saviour's CE Primary
St. Stephen's CE Primary
Bishop Thomas Grant RC
La Retraite RC
Saint Gabriel's CE College

Key
all-through school
nursery school
primary school
secondary school
special school

List of the 72 Lambeth schools covered in this HDP



Map of the London Borough of Lambeth with the 72 schools shown in blue

1.07 Methodology

This estate-wide HDP is underpinned by data collection and analysis by RAFT from September 2022 - March 2023. RAFT's database incorporates extensive information about all 72 schools and 231 buildings - see page below. It includes detailed information from Lambeth's planned maintenance and decarbonisation works programmes (see Section 2 below). It also includes assumptions on possible fabric and services measures and their costs.

The database is used to:

- model energy performance at a building block level and school level
- calculate energy consumption, carbon emissions, energy costs & capital costs
- provide information about the whole estate so that the scale of the issues and the measures required can be easily understood
- sort and prioritise schools in order to plan how best to implement the measures needed to achieve net zero compatibility across the estate

As a live database that can be continuously updated, it is possible to both **plan estate-wide works *and* track progress**. Critically, this database combines information about maintenance needs alongside calculations on energy and carbon savings, allowing **combined maintenance & decarbonisation planning**.

RAFT School Decarbonisation Database

INPUTS

Retrofit measures
Applicable fabric & services measures
Current & future carbon factors for gas & electricity

School/building information
School type, size & context
School energy use
Building geometry, fabric, services & condition
School engagement programmes
Planned maintenance & decarbonisation works

Costs
Cost rates for different fabric & services measures
Electricity and gas consumption costs

See Appendices for inputs

ANALYSIS

Energy, carbon & running costs
Calculate impacts of different retrofit measures on energy use, carbon emissions and running costs

Prioritisation & Planning
Understand issues affecting every school/building so that certain schools/ buildings can be prioritised when planning works across the estate

Quantities & upfront costs
Calculate quantities of retrofit measures at building, school and estate level - to both comprehend the scale of measures required and estimate upfront costs

See Proposals section for analysis

OUTPUTS

Estate understanding
Status of current estate with respect to energy, carbon, net-zero-compatibility and measures required

Estate planning
Proposed programme & school prioritisation
Estimated impacts - costs, energy, carbon

Estate progress
Information progress tracker
Measures progress tracker
Funding & costs tracker

See Delivery section for outputs

1.07 Methodology

The columns opposite outline the different types of information collated and inputted into the RAFT Database. The sources of data and how they are prioritised are detailed in the Appendix.

Data on the building fabric has come from a number of different sources. Generally glazing type, wall construction and roof coverings are known. However roof and floor construction are not, nor is the extent of insulation.

Archetypes

In order to make reasonable assumptions about a building's construction (if not known) and thermal performance, we have assigned all buildings an age-based archetype and determined core assumptions for each archetype.

The archetypes are:
- Historic: pre 1919
- Inter-war: 1920-1944
- Post-war: 1945-1966
- Modern: 1966-1976
- Post-oil crisis: 1976-2003
- 20th century: post 2023

See Appendices for sources of data

See Appendices for archetypes and assumptions

General
School Name
School Unique Number (URN & UPRN)
Postcode
No. of Pupils
% of Free School Meals

Environment
Local Index of Deprivation
Air Quality - PM2.5
Air Quality - PM10
Air Quality - PM NO2
Local Flood Risk
Local Overheating Risk
Listed Building on Site
Conservation Area

Engagement
Responded to RAFT Head Teacher Survey
Responded to RAFT Premises Survey
Attended Lambeth Premises Manager Training
Part of the Future Fit Network of Schools

Block Geometry
Block Name
Building Storeys
Gross Internal Area
Ground Floor Internal Area
Perimeter

Block fabric
Age of building and major extensions/refurbishments
Roof Pitch
Roof Construction Type
Roof covering type
Roof Condition
Wall Construction Type
Wall Condition
Curtain Walling Area
Curtain Walling - Proportion Glazed
Glazing Type & Glazing Condition

Block services
Existing Heat Network Connection
Air Conditioning
Lighting Type
Lighting Condition
PIR
ASHP
PV Panels
Ventilation System
Hot Water System Distribution
Hot Water System Fuel
Hot Water System Age
Hot Water System Controls
Space Heating System Fuel
Space Heating System Age
Space Heating System Controls
Kitchen Cooking Fuel
Kitchen Appliances Condition

Energy use
Gas use
Electricity Use
Meter Name (MPAN)
Meter Type (Half Hourly or Non-Half Hourly)
Ampage of Electrical Service Head
Maximum Half-Hourly Load

Planned works
Planned ASHPs
Planned LED
Planned PV
Planned Roof Insulation
Planned Wall Insulation
Planned maintenance works

Thermal performance
Archetype-based typical construction u-values
Archetype-based typical window to wall ratio
Archetype-based typical storey heights
Post-retrofit u-values

2.0 Estate Context

This section describes LBL's existing school estate including statutory, legal and environmental issues. The age, fabric and services of the estate's different schools and buildings are summarised, as are past and proposed decarbonisation and maintenance works.

Children searching for heat loss at their school

RAFT
Retrofit Action for Tomorrow

"Urban areas like Lambeth offer a beacon of hope in the fight against climate change"

Cllr Claire Holland, Leader of Lambeth Council, 2022

2.01 School types & sizes

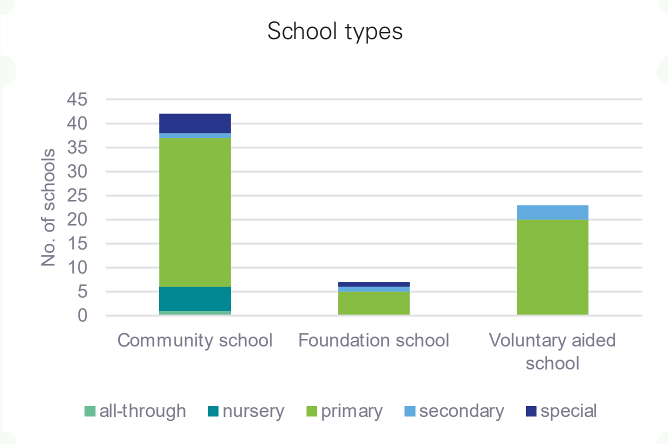
School types

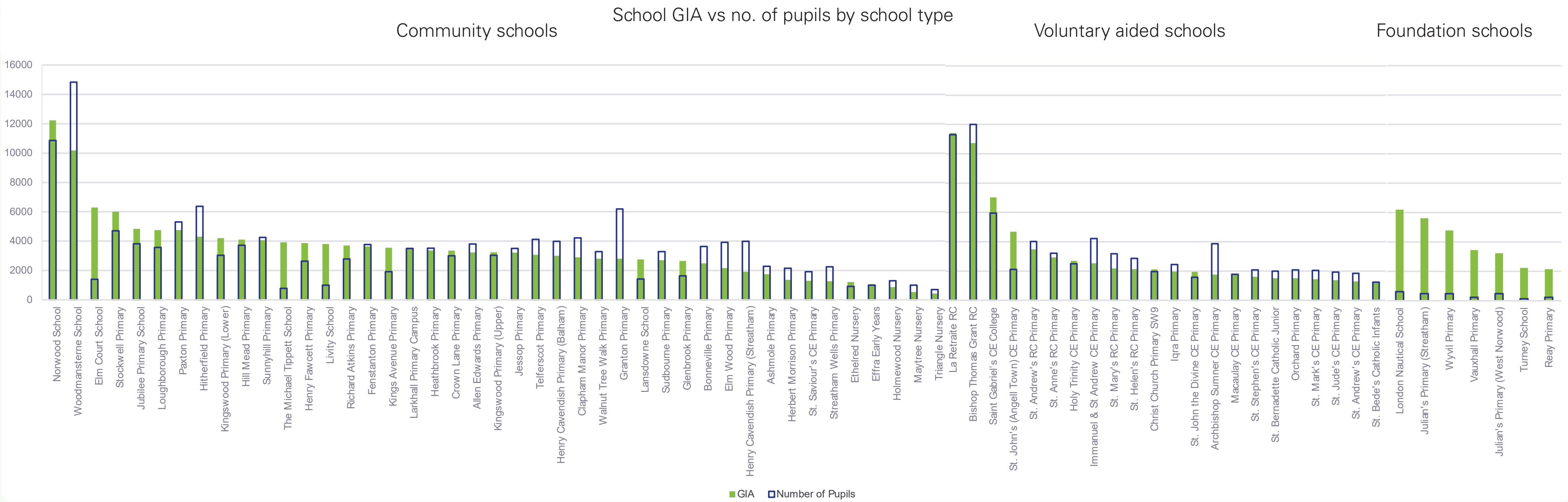
The 72 schools in this study are all in the London Borough of Lambeth in south London. They comprise nursery, primary, secondary, all-through and special schools. In terms of governance, there are community funded (41), Voluntary Aided (23) and Foundation schools (8). See chart right.

The organisation responsible for allocating funding and managing the decarbonisation works will vary depending on school governance. Lambeth Council manages the distribution of funding for running costs for all schools. However 'responsible bodies' manage the distribution of capital works funding.

School sizes

School sizes vary from 50 pupils (The Michael Tippett School) to 1500 pupils (Woodmansterne School) with an average of 330. The total gross internal area (GIA) of the schools ranges from 430m^2 (Triangle Nursery) to 12,250m^2 (The Norwood School). Four large secondary schools are between 10,000 and 13,000m^2. All the other schools are below 7000m^2. See graph below.





2.02 School estate environmental risks & deprivation

Environmental Risk

Environmental challenges faced by the schools include external air quality, overheating risk and flood risk. These were assessed using an online portal. (Firstplanit, 2023) Environmental information is in the RAFT Database but not used in energy modelling calculations.

Air quality indices are PM2.5 and NO_2 (mainly associated with car exhausts) and PM10, mainly associated with industrial equipment. These pollutants are known to have a detrimental effect on human physical and mental health. They are particularly damaging to children as they affect their cognitive and behavioural development. Both overheating risk and flood risk will increase with climate change.

School deprivation

The level of deprivation for each school was measured using the 2019 index of multiple deprivation. The deprivation index for each school is reflective of the Lower Layer Super Output Area (LSOA) in which it is located. (DLUHC, 2020) The majority of schools in this study were in the top 15-45% most nationally deprived with 7 within the top 15%. Also, at 12 schools, over 50% of pupils are eligible for free school meals compared to a national average of 22.5% (National Statistics, 2022).

Air Quality:

This area has been identified as **an area with poor air quality.** Of the 72 schools in this report, the vast majority were in areas of **High PM2.5, Medium NO2, and Low to Very Low PM10**.

Climate Heat Level:

The urban heat island risk level for Lambeth is high. The risk of overheating in all schools is High, with London Nautical School in central london classed as Very High.

Properties at Risk of Flooding:

The flood risk is Low to Very Low across all the schools.

2.03 School surveys

In addition to data gathered from online sources and provided by Lambeth council, RAFT sent out two online 'Typeform' surveys to all of the schools. 12 schools responded to the ***head teachers and business managers survey***, 11 to the ***premises managers survey*** .

Given the limited number of respondees they cannot be considered representative of the entire estate. However, fabric & services information from these surveys has been added to the RAFT database in line with the system of source-prioritisation noted in the Appendix.

Head teachers & business managers survey

This 20 minute survey covered school wide organisation and climate action, significant recent refurbishment works, critical maintenance needs and plans for future maintenance works.

Two respondents have both declared a climate emergency and signed up for Ashden's Let's Go Zero 2030 campaign (compared with 2,070 of the UK's 32,000 schools). Three respondents have a climate action plan and two noted that they have a heat decarbonisation plan.

Most of the respondents (8) decide the school's energy supplier and tariff, but nearly all either don't know (10) or are not (2) on a 100% renewable energy tariff. 4 Lambeth schools currently monitor and track their energy use, and 4 have smart electricity meters installed.

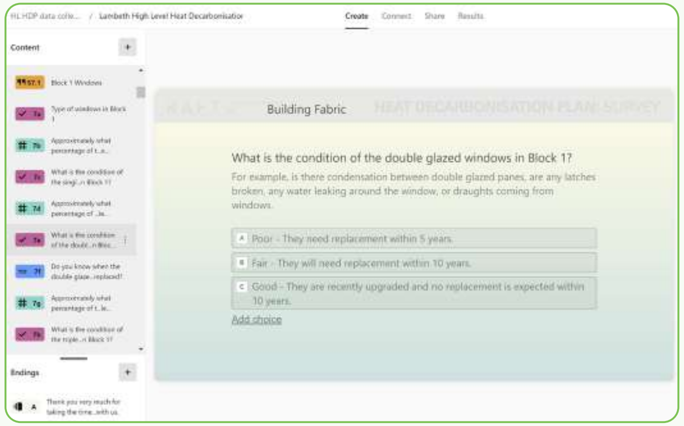
Four of the respondents have fossil fuel heating systems which need replacing within the next 3 years. Two of these schools have plans to change them in the near future. Seven of the respondents have identified critical maintenance works in need of addressing in the next year, and five have plans in place to identify future capital or maintenance works.

The respondees noted funding and a lack of resources within the school to manage the process as their main challenges to achieving zero carbon. They also felt that they lacked the skills and understanding required. Some schools also noted that they had hard-to-treat buildings with poor thermal efficiency. A couple of schools specifically mentioned that they are interested in the Council's plans for decarbonising their buildings but don't currently feel well informed.

Premises managers survey

This hour long survey sought information about the schools fabric, insulation, building services and electrics for each of the school's buildings/ blocks. Across the respondees:

- LED lights seem to be consistently being installed, especially as replacements
- Where ASHPs have been installed, commissioning is required
- There is a lack of understanding and competence about Building Management Systems and other building systems



2.04 Statutory and legal considerations

The following considerations need to be taken into account when developing school/building-specific HDPs and/or rolling out decarbonisation measures.

Planning Approval

Future site-specific Heat Decarbonisation Plans may require planning approval for:

- Any alterations to the buildings externally, including the replacement of windows.
- Any works that could impact trees within a conservation area.

Although it is likely that the works fall within permitted development, it is recommended that a pre-application consultation with the local authority planning department is carried out at every phase after the preparation of detailed design to check whether the proposed works will require a planning application to be made.

Heritage

Particular care should be taken in planning heat decarbonisation works to Listed Buildings. They would require planning approval and listed building consent. 6 of the schools assessed in this report have listed building(s) on their site and one has a locally listed building - see box opposite.

Heat decarbonisation works in Conservation Areas should ensure that they preserve or enhance the area's special character.

Existing trees on sites in Conservation Areas have a higher level of protection and plans should consider them from the outset. 12 of the schools assessed in this report are in conservation areas - see box opposite.

Building Control

The detailed design proposals at each stage will require building control approval for changes such as heat pump and MVHR installations, changes to heating systems, changes to thermal elements and other works such as electrics. It is recommended that a full plans application be made to the local authority building control department (or an approved inspector) at an early stage to ensure the proposed works meet the building regulations.

Health & Safety

The Construction (Design and Management) Regulations 2015 (Secretary of State, 2015) place responsibilities upon clients, to "ensure that the construction project is set up so that it is carried out from start to finish in a way that adequately controls the risks to the health and safety of those who may be affected".

Party Walls

If any planned works affect party walls, it is likely that a Party Wall Agreement will need to be sought with the adjoining owners. A party wall surveyor can assist with this.

Schools with listed buildings

1. Kingswood Primary School (Upper Site)
2. London Nautical School
3. Orchard Primary School
4. Richard Atkins Primary School
5. Sunnyhill Primary School
6. St Mark's Church of England Primary School

Schools with locally listed buildings

1. Telferscot Primary School

Schools in conservation areas

1. Archbishop Sumner Primary School
2. Clapham Manor Primary School
3. Elm Court School
4. La Retraite Roman Catholic School
5. London Nautical School
6. Orchard Primary School
7. St Anne's Roman Catholic Primary School
8. St Bernadette Catholic Junior School
9. St Mark's Church of England Primary School
10. Vauxhall Primary School
11. Walnut Tree Primary School
12. Wyvil Primary School

Note: The 3 schools in green have both listed buildings and are in conservation areas

Schools with planning applications pending

London Nautical School (an extension)

2.05 Existing estate fabric

Building archetypes

All buildings/blocks across the entire estate have been classified by archetypes which relate to school building eras - see graphic opposite:

- Historic (Pre-1919)
- Inter-war (1920-1944)
- Post-war (1945-1966)
- Modern (1967-1976)
- Post-oil crisis (1977-2003)
- 21st century (Post-2003)

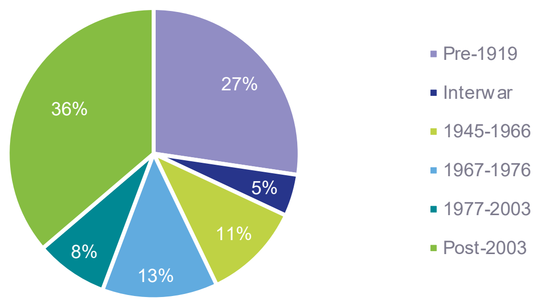
Around half of the estate’s 231 buildings were constructed after 1977, with a third constructed after 2003. Most schools have a mix of building archetypes on its site. See pie charts opposite.

Generally, building construction and condition is known from surveys - either council or national (CDC). It must be noted that the accuracy of CDC surveys can be problematic.

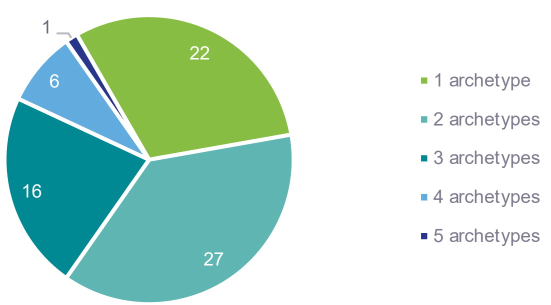
However, the thermal performance of fabric elements (eg. u-values) as well as glazing ratios and storey heights are based on archetype. In addition, if a building’s roof/wall/floor construction or window type is not known from survey information, we have applied archetype based assumptions.

See Appendices for Archetype details and assumptions

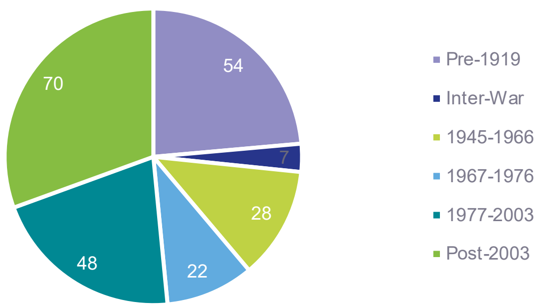
Percent of GIA by archetype

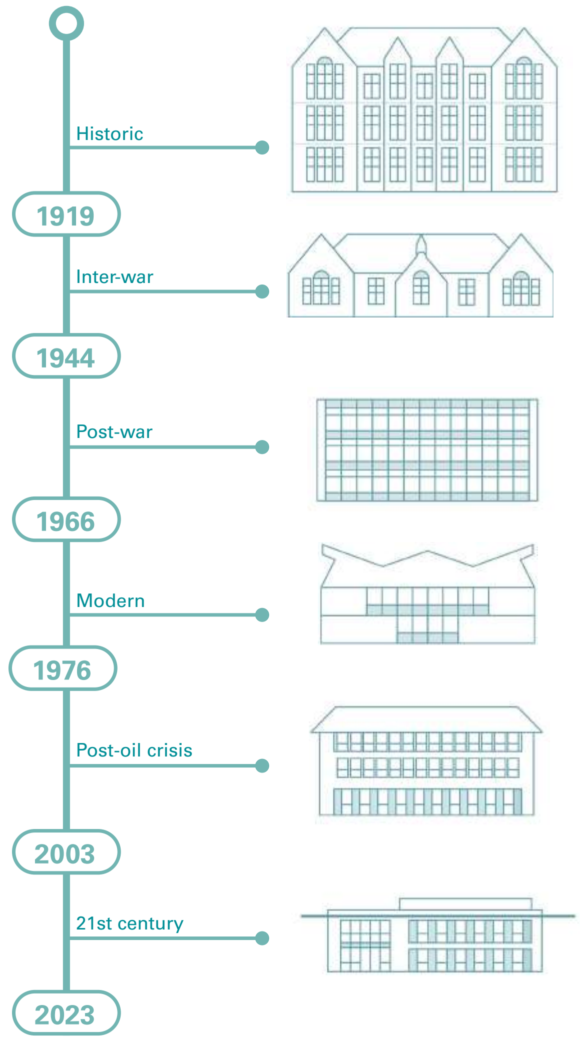


Number of archetypes per school



Archetype frequecy across estate by number of buildings





2.05 Existing estate fabric

Roofs

The extent of roof insulation is not known - only roof covering, pitch and condition. Retrofitting insulation into loft spaces beneath pitched roofs is typically easier than installing insulation under existing flat roofs - see section 3 below. Just over half the buildings have flat roofs, which will need surveying to determine whether insulation below the existing covering is feasible.

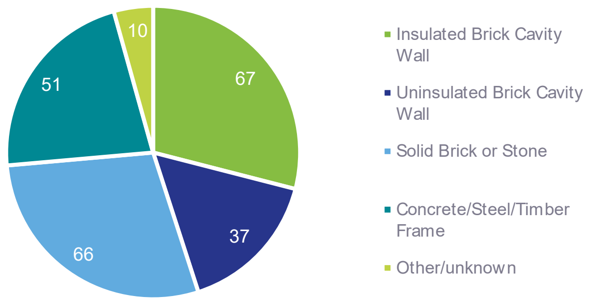
There is a large variation in roof coverings across the estate, and only one third of the estate's total roof area is considered to be in good condition. Roofs in poor condition pose both opportunities and challenges. On replacement, roofs can have their insulation and airtightness substantially improved. If not replaced, roofs in poor condition will hinder the installation of roof-mounted plant such as PV panels or ASHPs (although we recommend that the latter are not installed on roofs if possible).

Walls

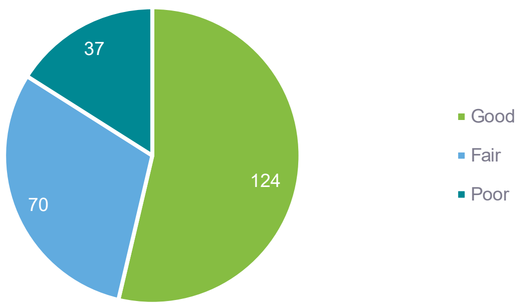
Just under half of the estate's buildings are thought to have uninsulated walls - either cavity or solid. The quality and quantity of insulation in the other walls is not known.

The majority of the schools' walls (by wall area) are considered to be in good condition - although problems with walls do tend to be overlooked more than roof issues so this may be misleading. Poor condition walls need attention because simply reducing damp (by maintaining walls and rainwater goods) improves a wall's thermal performance. Also, walls in poor condition will require repair prior to the installation of any wall insulation.

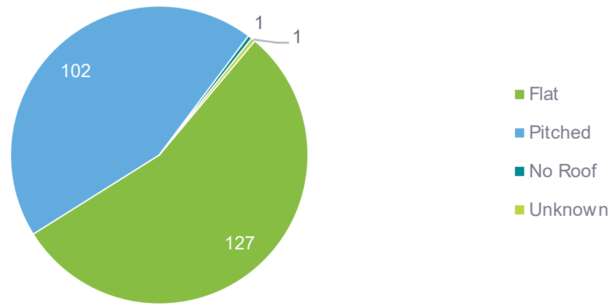
Wall type across estate by number of buildings



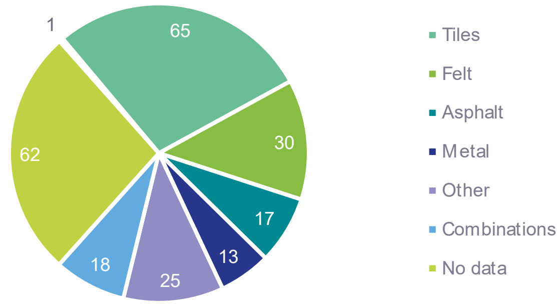
Wall condition across estate by number of buildings



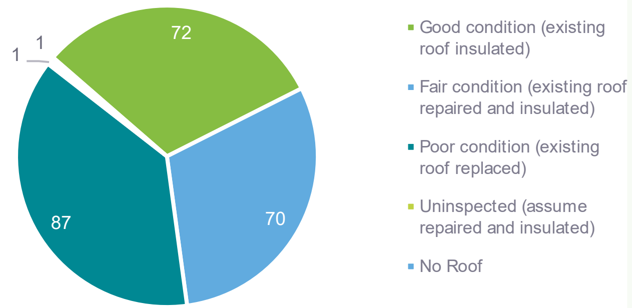
Roof type across estate by number of buildings



Roof covering type across estate by number of buildings



Roof condition across estate by number of buildings



2.05 Existing estate fabric

Windows

The majority of windows across the school estate are double glazed. However there are still 41 buildings that are primarily single glazed and a further 48 buildings that have some single glazing. In addition a third of the estate's windows are deemed to be in poor condition.

Poor condition windows and/or single glazing should be prioritised for replacement. On replacement they can be upgraded to triple glazing, which reduces heat loss and improves thermal comfort.

Floors

Information about floor construction or condition was not collected. Most floors are assumed to be solid concrete, although many pre-1945 floors may be suspended timber.

Insulation

Information about floor, wall and roof insulation is not typically collected in national CDC surveys or Lambeth's condition surveys although RAFT did cover insulation in the premises managers' survey. Consequently our understanding of insulation levels across the school estate is very poor and assumptions are based on archetype.

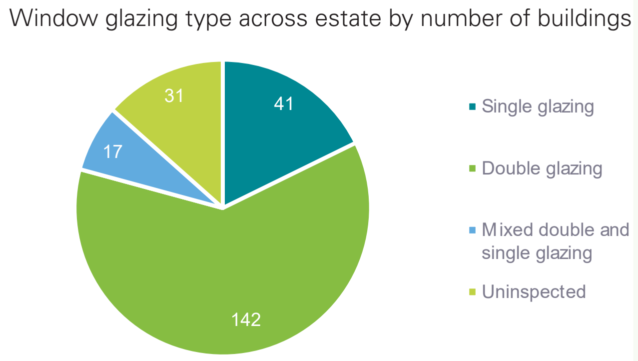
We have assumed that all insulation (if any) meets the building regulation requirements at the time of construction. In addition, we have assumed that 90% of roofs - if initially installed without insulation - have since been insulated.

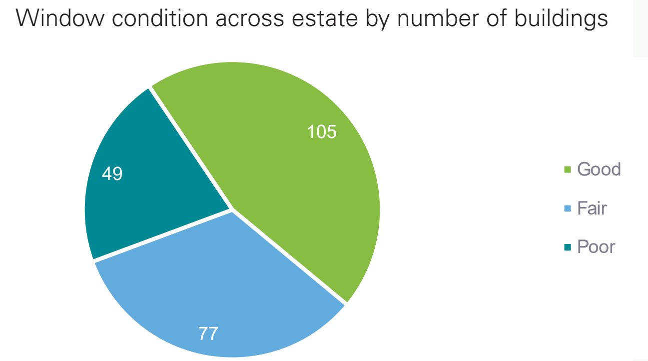
Fabric Risks

Reinforced autoclaved aerated concrete (RAAC) is a type of lightweight concrete used in the C20th, which is now presenting significant structural defects in buildings across the UK. According to the DfE, RAAC can existing in any buildings built between the 1930's and 1990's (DfE, 2022c). This affects the Post-War, Modern and Post-oil crisis archetypes. This report has not looked into RAAC. In the future, the presence or absence of RAAC should be investigated.

Asbestos is a material used in a wide range of building elements from pipe insulation to structural encasement to ceiling tiles. Any building built prior to 1999 may well have asbestos - either from when the original building was built, or from later extensions or refurbishments.

This affects around 70% of the estate's buildings. In RAFT's experience, most schools have asbestos. Asbestos surveys must be carried out before any retrofit measures can be undertaken.





2.06 Existing estate heating & hot water systems

Space heating systems

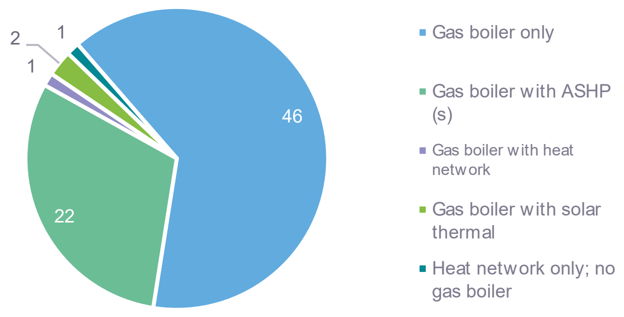
The vast majority of schools are heated by gas-fuelled boilers linked to high-temperature wet systems with radiators. **Only one school does not have gas boilers,** it is connected to district heating.

21 schools have ASHPs which work in tandem with existing boilers during shoulder seasons. One school has a gas boiler, ASHP and ground source heat pump. Two schools have solar thermal systems in addition to their gas boilers, neither of which appear to be functioning.

2 nursery schools are connected to district heat networks but school feedback suggests these systems are not serving them well. One of the two nursery schools uses additional electric heaters and fans to maintain comfortable temperatures. They also have a gas boiler although it's not clear if that is used for heating or hot water or both. They have indicated that urgent works are required for their gas boiler and that their smart meters are not working.

The second school also has "*issues around the heating and cooling of spaces*" and noted the following: "*a lack of understanding of the BMS within the school. We also have various systems that have been installed that we are not fully competent with. Trying to get support with these has proven challenging.*"

Existing heating system across estate by number of schools



Gas boiler only - 46 schools

Gas boiler + ASHP - 21 schools

Gas boiler + ASHP + ground source heat pump - 1 school

Gas boiler + solar thermal - 2 schools

Gas boiler + district heat network connection - 1 school

District heat network connection only - 1 school

2.06 Existing estate heating & hot water systems

The Mayor of London Heat Map (see map on right - GLA, 2014) provides information on existing and proposed large district heat networks (DHNs). It doesn't show minor DHNs.

Existing heat network connections

The Ethelred DHN serves the local estate. This very localised heat network is not shown on the map opposite but has been operational since 2010-2014 (Ramboll, 2010). Clapham Park DHN, which also serves the local estate, was established in the early 2010s.

Potential heat network connections

In a 2012 study for Lambeth, the Carbon Trust noted 5 schools in the vicinity of different heat network zones - see map opposite.

In addition, the proposed South Bank Employers Group (SBEG) heat network, will run near to the River Thames and could be utilised by one school. The proposed extension to the South East London Combined Heat and Power (SELCHP) heating network, which is already heating homes in the Borough of Southwark, could potentially be connected to schools in Kennington and Brixton.

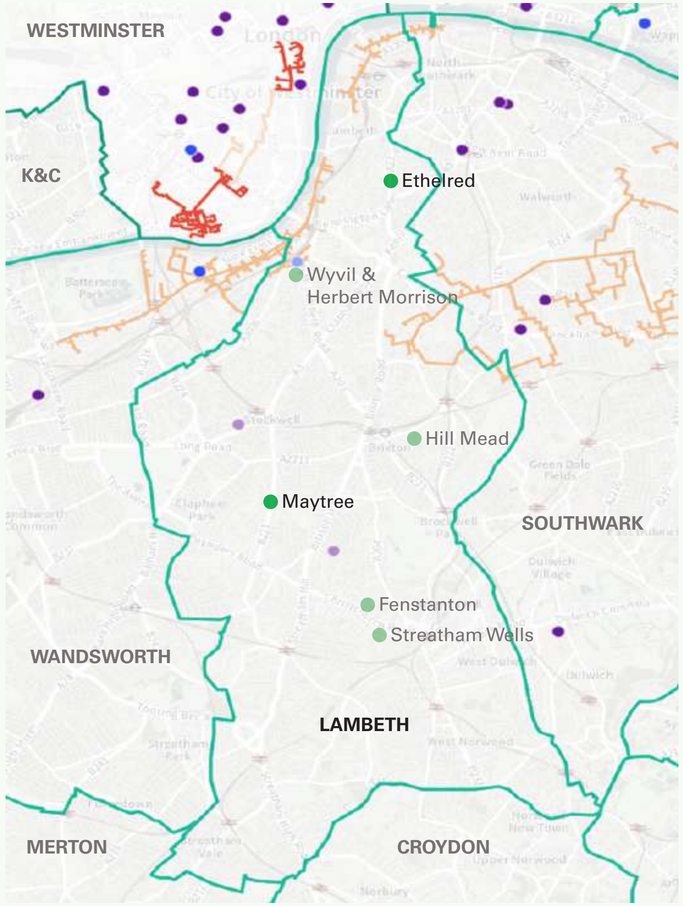
Also, potential heat supply sites are located throughout the borough and could form the basis for new district heating networks. These sites are predominantly Combined Heat and Power (CHP) with the addition of the EU Emissions Trading System (EUETS) site on Wyvil Road.

Although proposed DHNs could be connected into, Lambeth has no waste-heat industries (eg. data centres or waste incineration plants) or geological heat that they could tap into to create their own waste-heat DHNs.

Consequently, the Council view heat networks as useful for buildings where installing heat pumps is unfeasible - for example residential areas with lots of hard to treat homes or apartments - but do not have large scale plans to create heat networks.

In this HDP therefore, we assume that no new schools will be connected to district heat networks.

District Heat Networks (Mayor of London Heat Map)



- Existing DHNs
- Proposed DHNs
- Potential heat supply sites
- Borough boundaries

1. Whitehall
2. Pimlico
3. SBEG
4. VNEB
5. SELCHP extension

2.06 Existing estate heating & hot water systems

Boiler condition & replacement

In light of the climate emergency, boilers should never be replaced with new gas boilers. Instead, electric heating systems - ideally ASHPs - should be installed.

Unfortunately, within Lambeth, many schools are still replacing gas boilers with new ones. Nine schools have recently replaced their gas boilers. One school has recently bid to have its boilers replaced through VASCA funding. Also Lambeth Council plan to replace another school's out of action boiler with a new gas boiler in the coming year.

In addition, around a third of boilers are over 15 years old and 11 schools are deemed to have end-of-life boilers. There is a high risk these boilers will be replaced with gas boilers when they fail.

To mitigate against the risk of emergency replacement of failing boilers with new gas boilers, the Council and schools should have resilience plans in place for end-of-life boilers - see Section 5 Next steps.

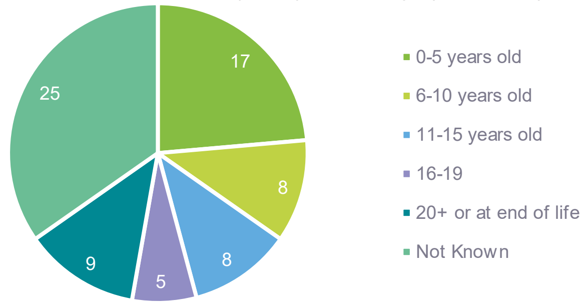
Water Heating Systems

Data on hot water systems was collected on a site-wide level. Generally, water heating systems were calorifiers connected to central boilers or heated by dedicated gas boilers. Individual electric or point of use water heaters were noted but no school appears to have electric water heaters as the main system.

Heat Emitters

Heat emitters are excluded from this study. They are assumed to be a mixture of old and new wet-radiator systems, wet underfloor heating and electric space heaters.

Boiler age across estate by number of heating systems (refers to each school's principal heating system only)



Schools with new gas boilers - 9 schools

Schools with end of life gas boilers - 11 schools

2.07 Existing estate electricity supply

Electricity Supply `

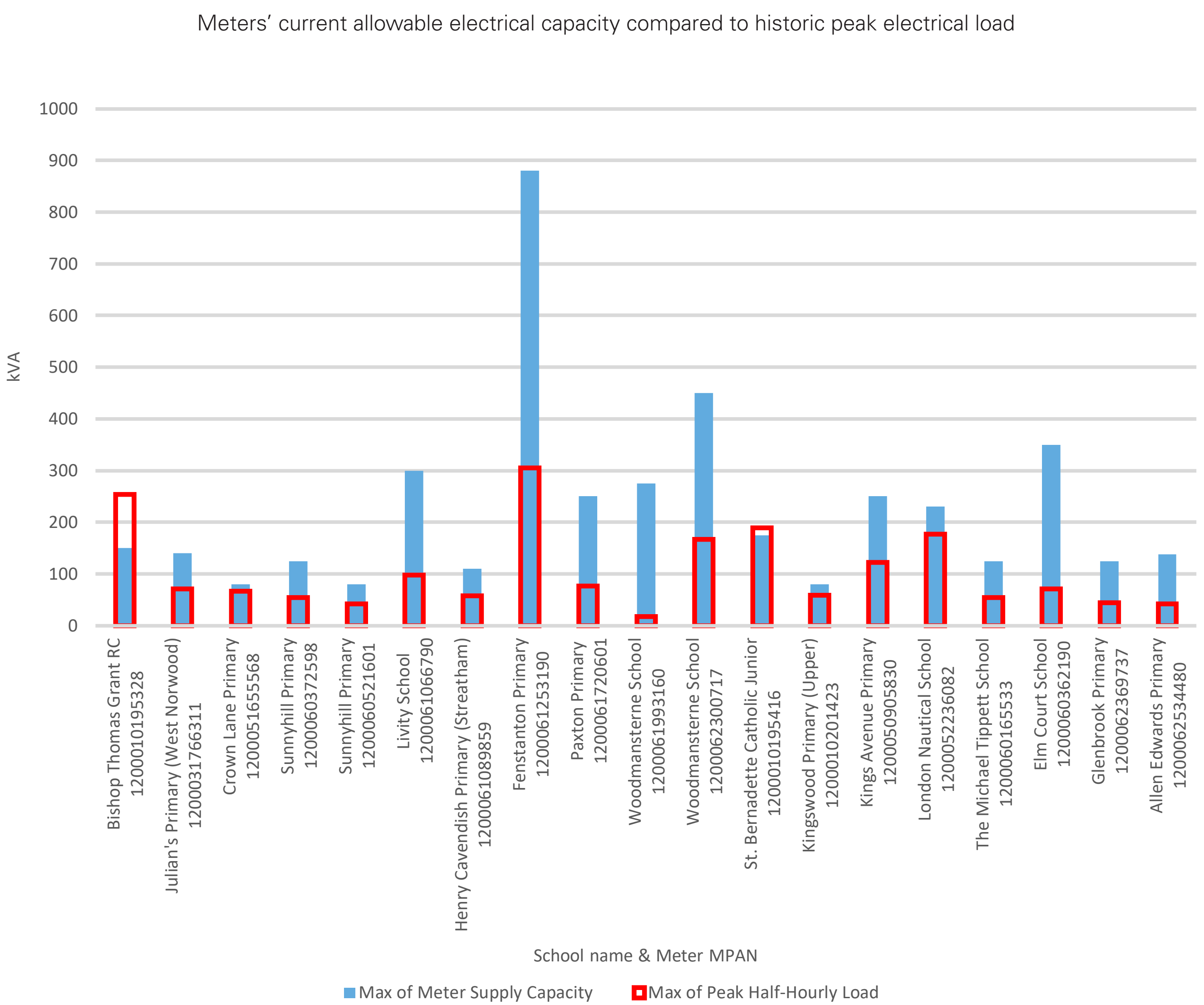
The district network operator, UKPN, provided meter information on the 72 schools. This information tells us each schools' meter type(s), their total allowable electrical capacity and - for some schools - peak electrical load data.

25 schools have only one meter, most have two or three meters, and a handful have four or more meters. Whilst many of the meters are domestic (Profile class 1), this is usually in schools with multiple meters. Consequently, all but two schools have 3-phase electrical supply.

The allowable electrical capacity varies enormously across the estate ranging from 23kVA to 1030kVA in a school whose meters supply both their site and an adjoining school.

Unfortunately peak electrical load information is limited to the 19 schools with Profile Class 0 meters. For all other schools, on-site load testing by an electrician will be required to obtain this information. Of the 19 schools, 2 have exceeded their allowable capacity, and another 2 are close to capacity. See graph.

Sufficient electrical capacity is critical to shifting away from gas boilers, because upgrading electricity supply to increase capacity can have enormous cost and programme implications.



2.08 Existing estate electrical systems

Electrical Storage

It seems that none of the schools have on site electrical storage. No battery storage or flow to electric vehicles from renewable energy generation on site was noted in condition reports or other surveys.

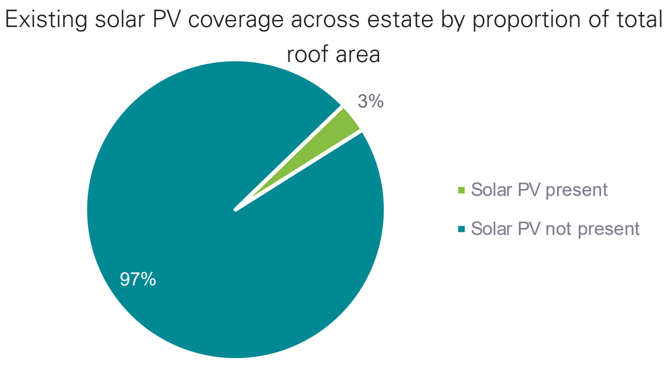
Existing Photovoltaic Panels

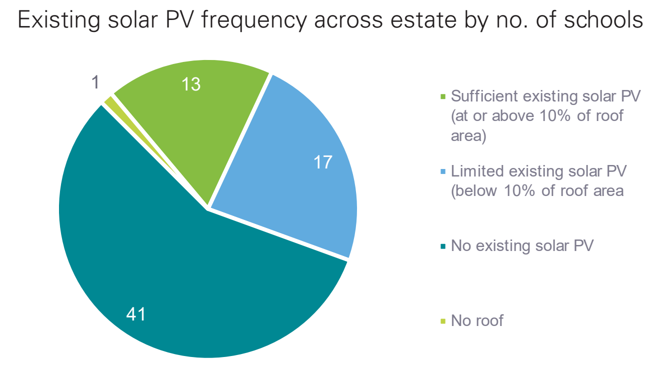
30 out of the 72 schools in the study currently have PVs installed with their PVs covering around 3% of the estate's total roof area. It should be feasible to cover at least 10% of roofs with PV so there is scope for a lot more PV. See pie charts opposite.

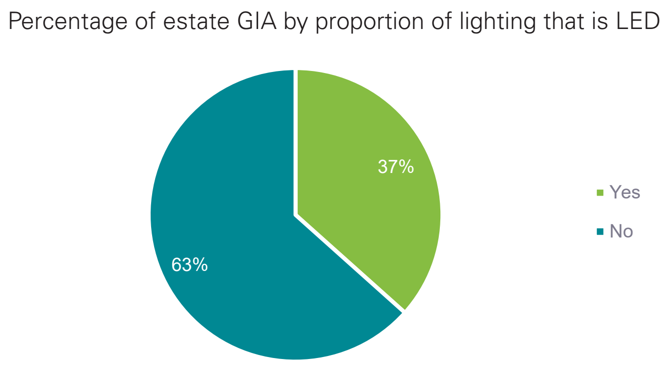
Lighting

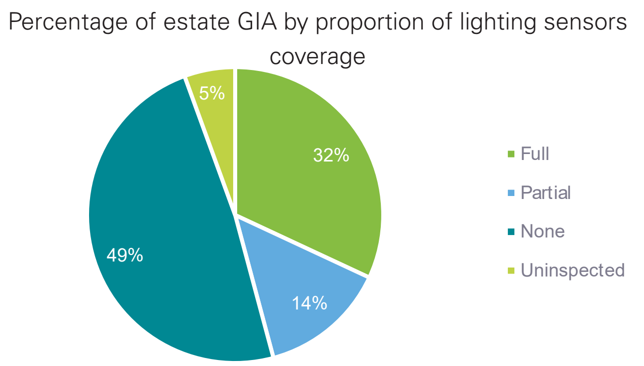
21 out of the 72 schools in the study have fully LED lighting. A further 24 have partial LED lighting (mainly mixed with fluorescent). The remaining 21 have no LED lighting. See pie chart opposite.

Almost half the schools are either fully or partially covered with motion sensors (PIR), daylight sensors or timers, used to turn off lights when not needed. See pie chart opposite.









2.09 Existing estate comfort & health

Comfort and health in a building go together with decarbonisation. When we improve insulation and airtightness (to reduce heat loss), we improve a building's thermal environment. When we introduce ventilation with heat recovery (also to reduce heat loss), we improve a building's indoor air quality.

Unfortunately, it was beyond the scope of this study to assess the health and comfort of all of the schools and their buildings.

However it is suggested that health and comfort monitoring is built into future building monitoring.

2.10 Existing estate thermal performance

Energy use intensity (EUI)

EUI is a measure of energy efficiency. It divides the energy consumed at the meter by the building's GIA. In buildings heated solely by gas, the gas EUI is a good indicator of how much energy is needed for heating. Buildings with a high gas EUI probably have a poorer thermal performance than buildings with a low gas EUI, although the efficiency of the heating system and the energy used for hot water are also important.

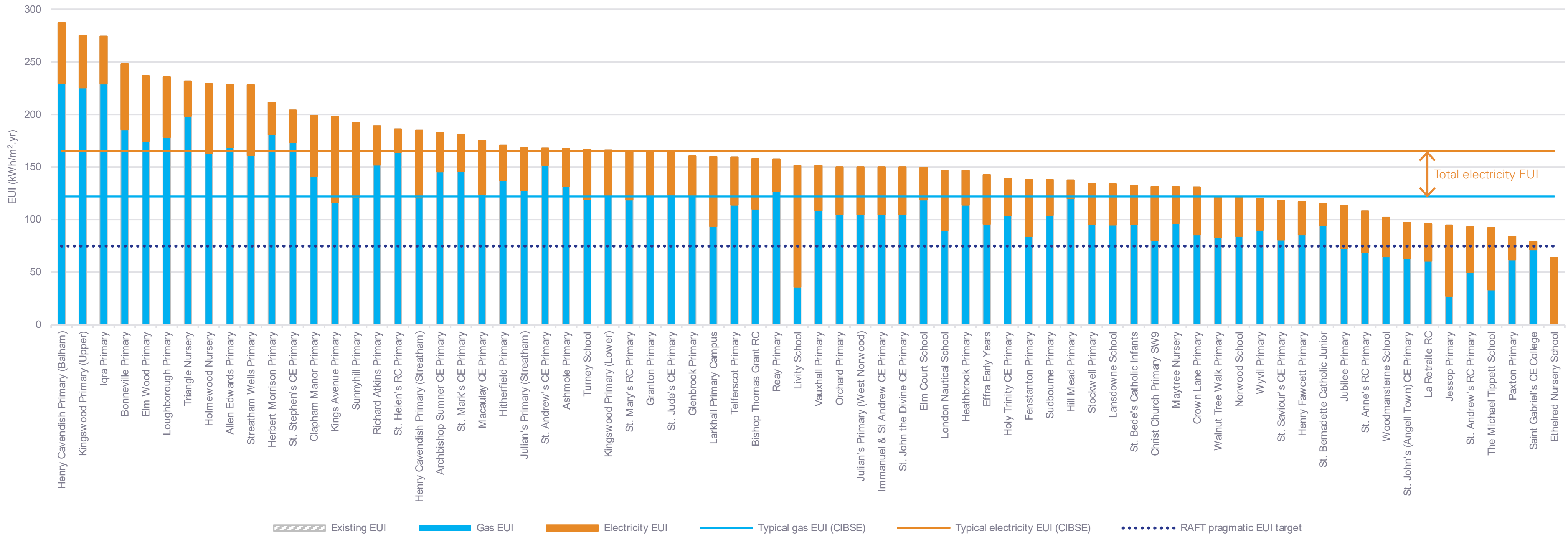
The graph opposite shows the total EUI of each school and compares with CIBSE benchmarks for typical UK primary schools. Whilst most of the Lambeth schools appear to perform better than the typical, only one meets the net-zero target of 75kWh/m2.yr. Also, there is huge disparity with gas EUI alone varying from 25kWh/m².yr to a very high 225kWh/m².yr. It is worth prioritising fabric measures and improving the efficiency of heating and hot water systems on schools with high gas EUI.

EUI (kWh/m².yr) = total energy consumption (kWh/yr) / GIA (m²)

If there is no energy consumption data for the school, an EUI of 150 kWh/m² has been applied, as that was the average energy use across over 100 Lambeth council and Southwark Diocese schools investigated by RAFT.

GIA data from school floor plans has been prioritised over GIA data from DECs. There are big discrepancies between the two sources, with DEC GIAs typically being smaller. This would suggest higher EUIs for schools based on DEC data, which is the source for CIBSE's benchmarks.

Existing energy use intensity



2.10 Existing estate thermal performance

Peak Heat Load kW

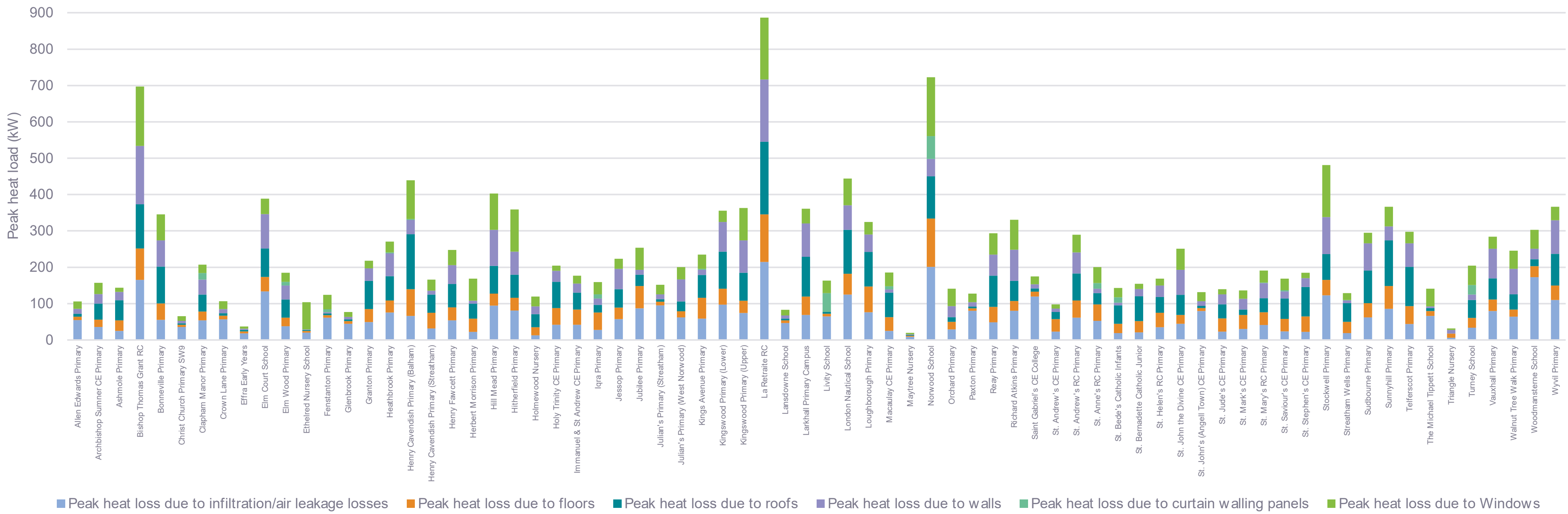
Peak heat load is an estimate of how much heat power is required to heat the building at a moment in time on the coldest day of the year. This is useful in two regards:

- understanding the thermal performance of the building because it shows how much heat is being lost from different elements
- sizing radiators and boilers/heat pumps to ensure they can deliver sufficient heat

The graph below shows the estimated peak heat loss (using the Salix peak heat loss calculator) of all 72 schools - arranged in order of size from highest to lowest GIA. 'Spikes' in the graph show schools with high levels of heat loss relative to schools of a similar size. This is a clear indicator of schools with poor thermal fabric that would benefit most from fabric measures. The graph is also useful for seeing where most heat is being lost for a given school. The proportion attributable to each fabric element varies from school to school. However heat losses due to infiltration are always significant and show how important it is to reduce leaks and draughts.

To summarise: there is great disparity in the heat loss of different schools. To maximise energy savings, focus fabric measures on large buildings with high heat loads.

Sum of existing peak heat loss through building elements and infiltration



2.11 Existing energy use & carbon emissions

The bar charts opposite show the existing EUI and carbon emissions of all 72 schools. Both charts are organised in order of size - from highest GIA to lowest GIA. Peaks in the graphs show schools which are less energy efficient (have higher EUIs). Troughs in the graphs show more energy efficient schools.

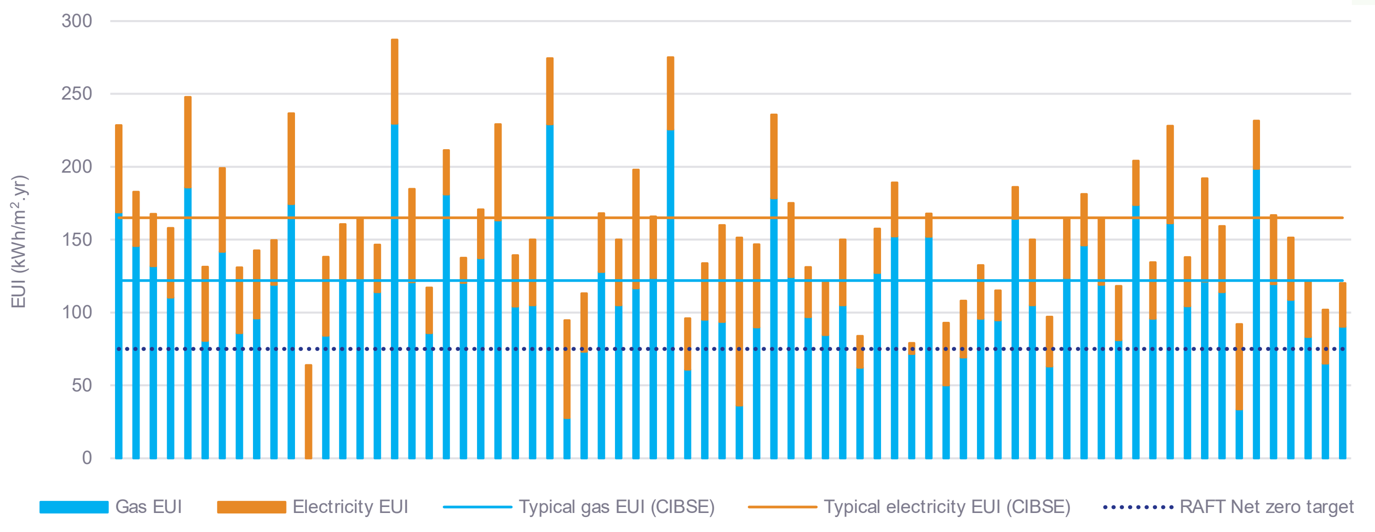
Schools with a high EUI are clearly less energy efficient and may well have more ‘low hanging fruit’ making it easier to improve energy efficiency and reduce emissions. However, it’s worth addressing large schools with high emissions, because small changes can have a big impact when applied across a bigger school.

Only one school does not have gas boilers and it’s the only school with an EUI less than the net-zero target. The school is linked to a district heating network, the energy from which is not recorded in the school’s energy bills or DEC.

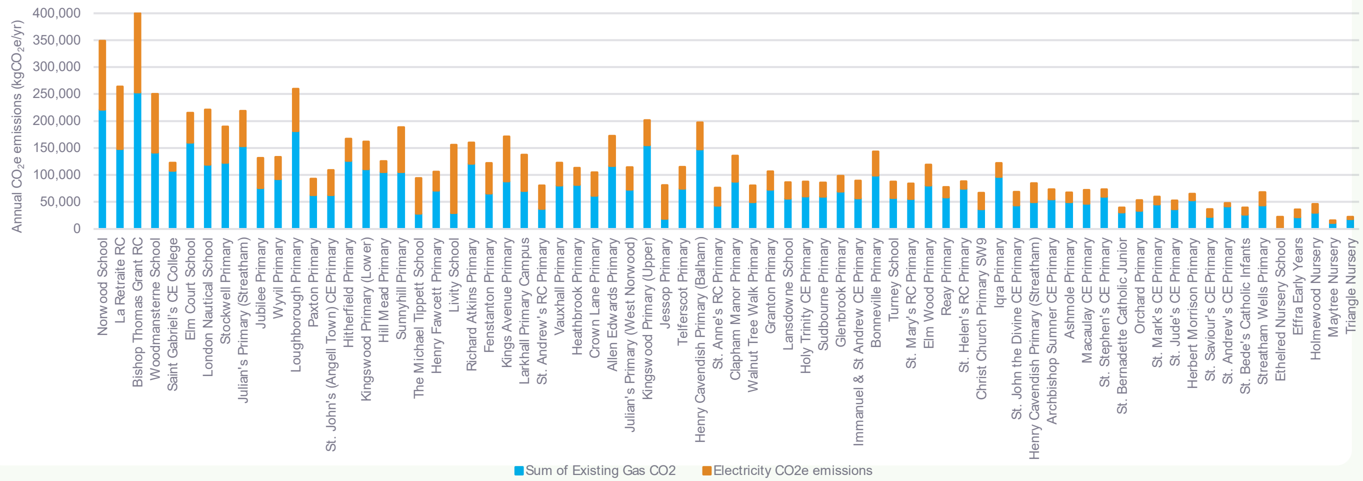
The table below summarises the whole estate’s current annual energy use/costs and emissions. Note that energy costs do not include for standing charges, nor for PV generation.

Fuel Type	kWh/yr	tCO_2e	Energy costs
Gas	26,000,000	5,500	£2.8m/yr
Electricity	10,500,000	3,000	£3.2m/yr
Total	**36,500,000**	**8,500**	**£6m/yr**

Schools existing energy use intensity ordered by GIA



Schools existing annual carbon emissions ordered by GIA



2.12 Decarbonisation works to date

The green box below summarises the various decarbonisation measures noted above that have already been installed across the estate, much of which were funded under the PSDS funding scheme. This scheme provides grants for public sector bodies to fund heat decarbonisation and related energy efficiency measures.

The table opposite outlines past PSDS-funded works. Note that all ASHPs are hybrid, with gas boilers still in use.

Works planned under PSDS3b are summarised below in Section 2.14.

Summary of decarbonisation measures across the estate

- **ASHP** (Section 2.06) : 22 schools have ASHP installed or in process, of which 20 are PSDS-funded.
- **Solar Thermal** (Section 2.06) - 2 schools have solar thermal systems.
- **Heat networks** (Section 2.06) - 2 schools are connected to a heat network.
- **Solar PV** (Section 2.08) - 30 schools have solar PV installed or in process.
- **LED Lighting** (Section 2.08) - 21 schools have full LED lighting. 24 schools have partial LED lighting.
- **Double or triple glazing** (Section 2.05) - 69% of buildings (159/231) have all or some double glazing but none have triple glazing.

PSDS 1 works (up to date December 2023)

School Name	Works	Funding (Sourced/Managed by)
Archbishop Sumner C of E Primary	ASHP, LED, solar PV	PSDS (Southwark Diocese)
Bishop Thomas Grant RC	ASHP, LED, solar PV	PSDS (LBL)
Bonneville Primary	LED	PSDS (LBL)
Clapham Manor Primary	ASHP**, LED	PSDS (LBL)
Crown Lane Primary	ASHP*, LED, solar PV	PSDS (LBL)
Effra Early Years	LED, solar PV	PSDS (LBL)
Elm Green School	LED, Solar PV	PSDS (LBL)
Heathbrook Primary	ASHP, LED, solar PV	PSDS (LBL)
Henry Cavendish Primary (Balham)	ASHP, LED, solar PV	PSDS (LBL)
Henry Cavendish Primary (Streatham)	ASHP, LED, solar PV	PSDS (LBL)
Hitherfield Primary	ASHP, LED, solar PV	PSDS (LBL)
Holmewood Nursery	ASHP, LED	PSDS (LBL)
Holy Trinity CE Primary	ASHP*, LED, solar PV	PSDS (LBL)
Immanuel and St Andrew C of E Primary	ASHP, LED	PSDS (Southwark Diocese)
La Retraite RC	ASHP, LED, solar PV	PSDS (LBL)
Lambeth Academy	ASHP, LED, solar PV*	PSDS (LBL)
Lansdowne School	ASHP, Solar PV	PSDS (LBL)
Macaulay C of E Primary	ASHP, LED, insulation	PSDS (Southwark Diocese)
Paxton Primary	ASHP, LED	PSDS (LBL)
Reay Primary	ASHP, LED	PSDS (LBL)
Rosendale Primary School	ASHP**, LED, solar PV	PSDS (LBL)
St Andrew's CE Primary	ASHP, LED, solar PV	PSDS (Southwark Diocese)
St Andrew's RC Primary	ASHP, LED, solar PV	PSDS (LBL)
St John the Divine C of E Primary	Roof insulation	PSDS (Southwark Diocese)
Streatham Wells Primary	ASHP, LED, solar PV	PSDS (LBL)
Sudbourne Primary	ASHP***, LED	PSDS (LBL)

Key
LBL status per latest information available, progress may have been achieved since
** Installed but awaiting DNO*
*** Installed but not commissioned*
**** Installation 80% complete – future of vacant building not known*

2.13 Planned decarbonisation & maintenance works

Lambeth council has decarbonisation and maintenance works planned for a number of schools under two funding programmes: School Capital Maintenance (SCM) and Public Sector Decarbonisation Fund (PSDS).

Lambeth School Capital Maintenance Programme (SCM programme)

Lambeth council carried out a comprehensive school condition review and works planning programme in mid 2021 - end 2022. Building condition surveys for all schools were followed by risk-based assessment, identification of specialist surveys needed and a review of historic and current capital works. This resulted in the identification of future capital works needs across 4 core areas: external envelope, mechanical & electrical, fire safety and damp or structural remedial works.

Following this, approximately 150 validation surveys were commissioned: External Envelope Surveys (33), M&E (24), Damp Investigations (13), Structural Surveys (19), Flat Roof Surveys (39).

The resulting programme identified approximately £58m of works in those four core areas, with a shortfall of approximately £45m beyond current funding (DfE capital works grant allocation plus alternative sources).

Recognising that capital works funding for Voluntary Aided schools is received directly by the Diocese or other responsible body, Lambeth council has excluded these from their capital works programme, resulting in a reduced estimated capital works requirement of £41m, and a shortfall of around £28m.

Lambeth council's capital works team have recognised that it is not possible to prioritise school condition works based on need.

They have therefore developed an "extracted" programme of scheduled works for 2023-2025, capping work per school to deliver the most amount of work across the maximum number of schools. In addition, they are investigating additional funding to support the remaining work, which remains planned as "under review".

2.13 Planned decarbonisation & maintenance works

Public Sector Decarbonisation Scheme (PSDS3b)

Certain works identified in the school estate review above, resulted in PSDS 3b applications in 2022. Grants have been awarded for works on six schools - £2.3m grant funding alongside up to £3.5m Lambeth council co-funding. A second PSDS3b application is pending for nine schools. See table opposite.

The applications covered the following measures:

- all schools: replace gas boilers with ASHPs
- some schools: install direct electric hot water systems
- initial 6 schools: various enabling measures such as LEDs, solar PV
- pending 9 schools: various fabric improvements such as glazing replacement and roof insulation

PSDS 3b grant eligibility criteria requires:

- The funding provided to save a tonne of direct carbon (tCO2e) over the lifetime of the project (Carbon Cost Threshold) must be no more than £325 - this can be calculated with a tool to assess eligibility
- The applicant should contribute the cost for a like-for-like replacement at a minimum of 12% of the total project costs
- The application should have energy efficiency costs that do not exceed more than 58% of the grant value
- The application should have all energy efficiency measures directly serving buildings served by the low carbon heating element.

Lambeth council's capital works budget may be insufficient to fund the co-funding requirement of PSDS3b, without alternative funding sources.

PSDS 3b works (up to date December 2023)

School Name	Works	PSDS 3b status
Fenstanton Primary School	ASHP, Flow Restrictors, Solar PV	Delivery phase
Livity School	ASHP, Flow Restrictors, Solar PV	Delivery phase
Loughborough Primary School	ASHP,LED, Flow Restrictors, Solar PV, Double Glazing	Delivery phase
Richard Atkins Primary School	ASHP, Flow Restrictors, Solar PV, Double Glazing	Delivery phase
St Helen's RC Primary School	ASHP, Flow Restrictors, Solar PV	Delivery phase
Hill Mead Primary School	ASHP, Flow Restrictors	Delivery phase
The Norwood School	ASHP, Flow Restrictors, Solar PV	Delivery phase
Elm Court School	ASHP, LED, Flow Restrictors, Solar PV	Delivery phase
Kings Avenue Primary School	ASHP, LED, Flow Restrictors, Solar PV	Delivery phase
Herbert Morrison Primary	ASHP, LED, Flow Restrictors, Solar PV	Delivery phase
Henry Fawcett Primary	-	Design complete, not progressing for delivery
St Saviour's CE Primary	-	Design complete, not progressing for delivery
Telferscot Primary	-	Design complete, not progressing for delivery
Walnut Tree Walk Primary	-	Design complete, not progressing for delivery
Woodmansterne School	-	Design complete, not progressing for delivery

2.14 Decarbonisation engagement programmes

Existing engagement programmes

Lambeth's Future Fit Schools Network
Launched in November 2022, this network brings schools together to tackle the climate crisis. It aims to support schools in setting climate goals, taking practical action and becoming climate champions. It combines expert workshops, peer-to-peer learning and sharing and collaboration with the Council's climate change team. Delivered by the Council with the support of RAFT, Lets Go Zero 2030, SE24 and other climate action organisations.

Energy Workshops for School Premises Managers
This programme launched in January 2023 and was designed to give premises managers practical help to deliver energy and cost savings. It is a series of online workshops and drop-in seminars which also seeks to track and quantify the actions taken and expected energy and emissions savings. Delivered by RAFT in collaboration with the Council.

"At these sessions, in addition to participating in the discussions and workshops, your premises manager will hear about energy saving initiatives at other Lambeth schools, share their own work and be able to forge links with both RAFT and their colleagues in other schools. In addition to reducing carbon emissions, it is anticipated the actions taken arising from the workshops will have a positive impact on school's energy usage contributing to the on-going management of school spending on energy." Lambeth School Services invite

School Workshop Programme
This 5-school programme of bespoke workshops launches in April-May 2023 and includes practical pupil workshops, a pan-school assembly and staff workshop, It aims to drive deeper knowledge and engagement around emissions, school building performance, retrofit & efficiency action and the school's full carbon footprint. As well as awareness of the wider global context, green skills and future areas of opportunity for pupils in their jobs and careers.

Delivered by RAFT in collaboration with the Council, the programme starts with schools which have previously received PSDS-funded measures, to build awareness, maximise impact of measures, generate learnings and facilitate case study knowledge-sharing via the wider Future Fit Schools Network.

Future engagement programmes

A **post-HDP momentum building programme** could assist schools with HDPs in implementing their retrofit measures. **Estate-wide monitoring training** would show schools how to install and maintain energy meters and thermal/IAQ monitors. Finally an **energy management diagnosis & support programme** for schools with energy monitoring, would help them build their data into immediate energy efficiency actions.

Why is engagement so important?

Engagement can be one of the most significant catalysts for action. Effective knowledge-sharing develops understanding, changes hearts and minds, increases personal 'light bulb' moments and helps envision our decarbonised future and the possibility of change.

Thus expected outcomes range from reducing barriers all the way through to active, whole-hearted agency and support that drives climate action.

Within school communities this in turn builds, demonstrates and communicates climate leadership, climate justice – a just transition for all communities, building-related impacts and co-benefits, future jobs & careers and real momentum for change.

It is also recognised that across different audiences, school types and priorities, a range of engagement and communication programmes help to reinforce and build, amplifying messages and impact.

3.0 Proposals

The following pages describe the school buildings that are part of this HDP at a block level including their physical context, condition and energy consumption. It also provides the methodology used to calculate the school's energy usage and GHG emissions.

Thermal model of the Francis Building, DVI.

RAFT
Retrofit Action for Tomorrow

"We need to take a whole buildings and whole-system approach to minimise costs of decarbonisation."

HM Government, Heat & Buildings Strategy, 2021

3.01 A whole building approach

For a school to achieve net-zero-compatibility, a suite of measures are required to **reduce energy demand, remove on-site fossil fuels and maximise on-site renewable energy**. These measures should be supported and evidenced through ongoing performance and energy monitoring. See graphic opposite.

A whole building approach

When combined these measures can bring enormous benefits beyond carbon reductions, including improved comfort, better building health and lower energy bills. However, some measures can have negative knock-on impacts if not carried out carefully.

Thermal upgrades will increase the airtightness of a building, which can cause issues with indoor air quality and moisture. To mitigate this, ventilation should be improved alongside thermal upgrades.

Removing gas from heating, hot water and kitchens will increase electricity usage and peak electrical loads. This could result in higher energy bills (because currently electricity is 3-4 times more expensive than gas) and problems with electricity supply capacity.

A whole building approach is required, with four key priorities. These are outlined on the following page.

Reduce energy demand

Thermal upgrade – *To all walls, floors, roofs and openings, improve or add insulation, maintain moisture characteristics, reduce air infiltration.*

Ventilation – *Mechanical Ventilation with Heat Recovery coupled with reducing air leakage to recover waste heat, improve indoor air quality and reduce mould risk.*

Energy management – *LED lighting replacement, adding PIR/timers & other power saving controls, reducing kitchen loads, balancing electrical loads.*

Remove on-site fossil fuels

Decarbonise heating, hot water & kitchens – *Replace fossil fuel heating systems with low carbon alternatives, sized appropriately for future building fabric performance. Ensure hot water provision and kitchen hobs and ovens are all-electric.*

Maximise on-site renewables

Heat pumps – *Use heat available in the surrounding air, water or ground via a heat pump.*

Solar PV – *Schools typically have large roof areas that can be utilised for Solar PV that contribute to electricity generation.*

Ongoing monitoring – – *The school should record and track its energy performance over time to help identify where to target action by reducing waste and improve efficiency. As retrofit works are carried out over time, tracking energy savings will help to support on-going action, consolidate behaviour change and demonstrate an evidenced business case of energy savings.*

3.02 Key priorities

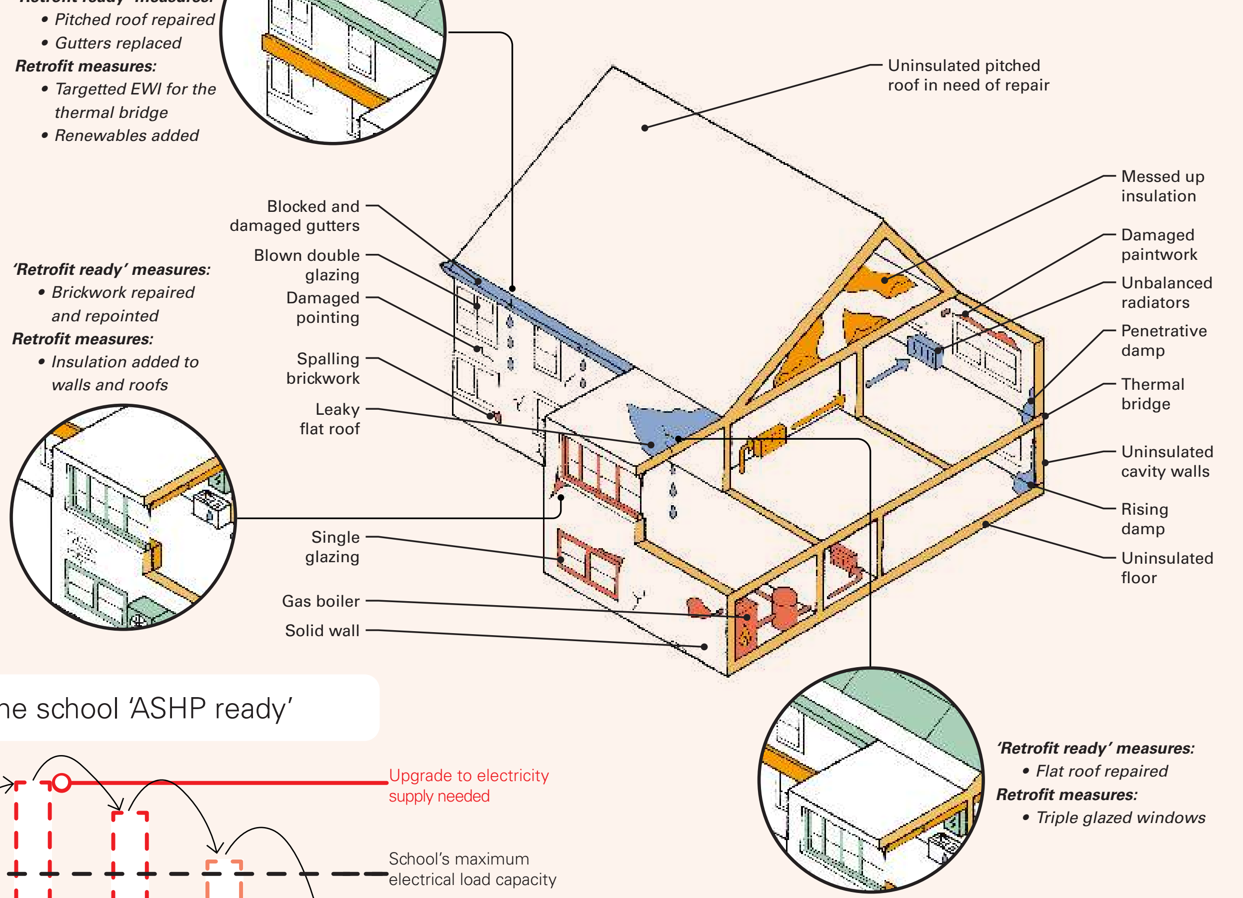
1. Be 'retrofit ready' by maintaining and repairing the fabric of an existing building. Basic maintenance (e.g. rain protection) should be a precursor to efficiency measures because fabric defects impact on building performance. Making a building 'retrofit ready' will help reduce energy demand. It's therefore critical that maintenance and decarbonisation works go hand in hand. It is also advantageous to combine such works to reduce costs and disruption.

2. Be 'ASHP ready' by reducing energy demand and peak loads before installing ASHPs. If heat demand isn't reduced, the capital costs of the heat pump will be greater, energy costs may be higher and it will be difficult to heat the building. If peak electrical loads (from heat and non-heat) aren't reduced, the school may face electrical capacity issues resulting in expensive electricity infrastructure upgrades - see graphic opposite.

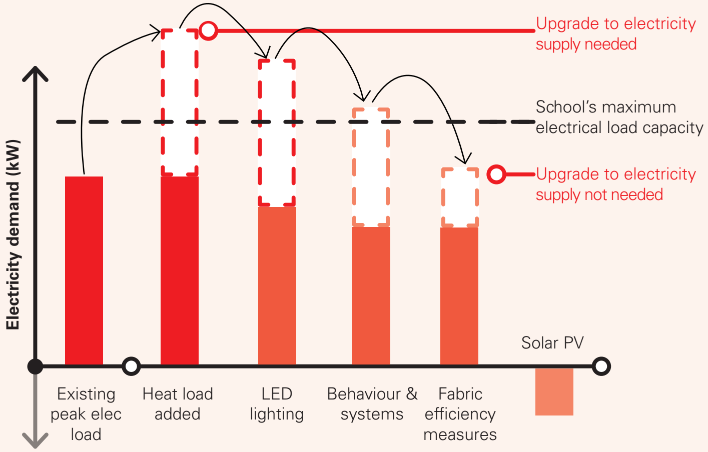
3. Improve ventilation alongside fabric upgrades to reduce the risk of poor indoor air quality (IAQ), which is already very bad in many schools. Introducing mechanical systems with heat recovery (MVHR) provides the added advantage of reducing heat loss and therefore energy consumption for heating.

4. Monitor existing energy use to help shift behaviour and make an evidenced case for where measures/funds should be focused.

Getting the school 'retrofit ready'



Getting the school 'ASHP ready'



Estimated reduction following identified measures

3.03 Measures

The table opposite summarises the suite of measures that can be considered for each and every school. These are discussed in more detail on the following pages.

The measures are then bundled into different packages that can be applied at either a school or building level.

- Package 1: the basics
- Package 2: immediate fabric measures
- Package 3: heating system measures
- Package 4: pragmatic full retrofit
- Package 5: ambitious full retrofit

The impact of the different packages are then assessed at a school and estate level.

It is worth noting that any fabric measures must be considered as part of a whole-building approach to retrofit. This is because introducing insulation and airtightness measures can result in unintended consequences such as poor air quality, damp and increased fire risk. To negate these risks, fabric upgrades should be done in tandem with improved ventilation and basic maintenance to ensure building elements are protected from rain ingress. Also, the fire risk of insulation materials should be assessed.

STAND-ALONE MEASURES
subject to good roof condition for PV

Energy management & monitoring
Energy monitoring & display
Submetering
Air quality monitoring & display
Heating/hot water systems management
Electrical systems management
Reducing electricity demand
Ensure all lighting is LEDs
Install PIRs/timers on lights
On-site electricity generation
Install solar PV on roofs

IN TANDEM WITH LOAD & DEMAND REDUCTION

Removing on-site gas
Replace gas boilers with ASHPs/GSHPs
Connect to district heating network
Upgrade heating pipes and emitters (radiators)
Replace gas-fired central hot water storage & distribution with electric point of use hot water
Replace gas hobs/ovens with all-electric appliances

MEASURES MUST BE CONSIDERED AS PART OF WHOLE-BUILDING PLAN

Fabric measures
Cavity Wall Insulation (CWI)
Internal Wall Insulation (IWI)
External Wall Insulation (EWI) + thermal skirt
Floor Insulation
Flat roof insulation
Pitched Roof insulation (along pitch)
Pitched Roof insulation (loft level)
Airtightness improvements
Replace windows and doors
Repair & draught proof windows & doors
Ventilation measures
MVHR (centralised or decentralised)
MEV (centralised)
Natural ventilation (windows)

3.04 Energy management & monitoring

As a starting point, there are simple measures every school can undertake to manage and monitor energy better, thus reducing energy consumption and emissions without high capital costs. These are identified opposite.

Good energy practice should endure over the full project time line and be a continuous engagement & learning process.

What temperatures should rooms be set to?
Reducing internal temperatures by 1°C can reduce space heat demand by up to 1/3. The DfE advises the following internal temperatures (DfE 2022a)

- Classrooms and dining areas - 20°C
- Gyms and sports halls - 17°C
- Medical rooms - 21°C
- Offices and staff rooms - 20°C
- Corridors and toilets - 17°C
- Kitchen prep areas - 20°C

Embedding good energy practice

Monitor meter readings regularly to understand patterns of energy use. Keep a record of consumption and costs.

Get pupils and staff involved in understanding where energy is used and where it could be saved.

Create a dashboard of carbon emissions saved by the school and provide an update to the school community through newsletters.

Label light switches to make sure only those needed are turned on.

Remove obstructions from windows to maximise daylight and winter solar gains. Actively manage use of blinds to ensure they're not down unnecessarily.

Label all equipment (switches and plugs) so that all school users know what they can switch off at night/weekends. For example: printers, photocopiers, PCs whiteboards, TVs, projectors, water coolers and heaters.

Appoint an electrics champion to ensure all lights and equipment are switched off at the end of the day.

Reorganise classroom spaces to increase comfort by moving people away from sources of heat (radiators) and cold (external windows).

Keep windows and doors closed when heating is on except where required for ventilation. If rooms are overheating, turn down the heating system rather than open windows.

Minimise use of direct external doors if possible. Use external doors with lobbies or cloak rooms.

Do not block radiators with furniture as this prevents heat from being distributed effectively and can cause the heating system to operate more than necessary.

Systems & Maintenance

Make sure boilers are serviced at least annually and adjusted for optimum efficiency. Have low flow temperatures.

Check temperature controls and timers on heating and air conditioning systems to avoid out-of-hours or excessive heating/cooling. Check that timers are set to actual hours of use and thermostats are set to lowest levels comfortable. Ensure thermostats are functioning correctly and not positioned near heat emitting equipment.

Heat hot water stored in cylinders to 60°C, not higher.

Ensure Building Management Systems and heating systems controls are understood and regularly checked.

Tidy up insulation in accessible roof spaces to stop heat from escaping.

Draught proof very leaky windows/doors and service penetrations

Fix any leaking gutters as wet walls will lose more heat than dry walls

Ensure kitchen appliances and ventilation systems are only turned on when they are needed during the day to reduce unnecessary waste. Locate fridges and freezers away from heat sources and ensure they're regularly defrosted. Run minimal freezers/fridges during the holidays.

Consider pre-heating kitchens in the morning to avoid staff using kitchen appliances to provide heat.

Rebalance electrical loads on fuse boards and install half-hourly meters to reduce the amount of energy billed for.

Be always congniscent of existing asbestos in the building and assess risk when undertaking even simple measures and surveys

3.05 Electricity demand & generation

Electricity demand due to lighting can be substantially reduced with the installation of energy efficient LEDs and sensors/timers to reduce lighting use. Renewable electricity can be generated by installing solar PV panels on the roofs of schools. Other renewables like wind are not appropriate for urban sites.

LED Lighting

High-efficiency LEDs are proposed to replace all fluorescent and halogen lighting. LED lights use less energy during operation and last longer than other types of lights.

PIR, daylight sensors & timers

Timers, PIR (motion) sensors and daylight sensors can be used to automatically switch off lights when they're not required. This reduces energy use from lights being left on unnecessarily.

PIR sensors are proposed in hallways, toilets, or other areas with low direct sunlight. Daylight sensors are proposed externally and in classrooms, halls or atria. They will switch off lights if the level of natural light rises above a certain lux level.

Both LED lighting & PIR/sensors/timers are low cost measures that can be installed as stand-alone measures.

Solar Photovoltaic (PV)

Schools are heavy users of daytime electricity and can therefore benefit greatly from PV generation, which can reduce energy bills and balance out increased electrical demands from electrified heat.

PV panels are ideally paired with either battery or hot water storage so that energy can be stored if not required at the moment of generation.

Panels can be mounted on flat roofs or pitched roofs facing south, southeast or southwest that aren't overshadowed. The output of the panels will vary depending on panel efficiency, orientation and overshadowing. The box opposite notes some average values.

PV can be installed independent of other measures. However, roofs need to be structurally sound and in good condition. Also, if a roof needs to be insulated from above, this is worth doing prior to PV installation.

See Appendix 6.07 for more information on each measure proposed

PV energy generation
Assume 10% of roof area can be covered by PV
Average peak output: 200Wp/m^2
UK kK factor: 950 kWh/kWp.year
Annual output: 190kWh/m^2 (peak output x kK factor)

Lighting energy consumption
LED lighting with PIR/sensors: 4kWh/m2.yr
Fluorescent lighting without PIR/sensors: 8.4kWh/m2.yr

3.06 Removing on-site gas

The energy required to supply heating and hot water can be dramatically reduced by installing more efficient heating and hot water systems.

Heating Systems

Existing gas boilers should be replaced with heat pumps. Heat pumps are 2-7 times more efficient than gas boilers. In addition they use electricity rather than gas and so carbon emissions will reduce as the grid decarbonises - see graphic opposite.

However some heat pumps use refrigerants with very high global warming potential (GWP) leading to high carbon emissions when refrigerants leak. Refrigerants with a GWP<10 should be specified.

There are different types of heat pumps including air-source (ASHPs) or ground-source (GSHPs). ASHPs are typically the easiest to instal and are therefore proposed here. They must be installed outside.

ASHPs work most efficiently at low temperatures and therefore require low temperature emitters and distribution pipework. If peak heat loads are sufficiently reduced it may be possible to retain existing emitters (radiators), which reduces costs.

That said, retaining existing pipework and radiators can lead to complications during construction and on-going operation. For example, poor connections in existing pipework may cause leaks or bleed valves may not be operable.

Note that connecting to district heat networks is not proposed as discussed in Section 2.

Hot Water Systems

Point of use (POU) hot water systems significantly reduce storage and distribution losses. They also avoid the efficiency losses associated with gas boilers.

For spaces with only one or two basins, direct electric POU water taps are best. For large WC blocks and kitchens, a shared local hot water cylinder with direct electric is more economical to instal.

Kitchens

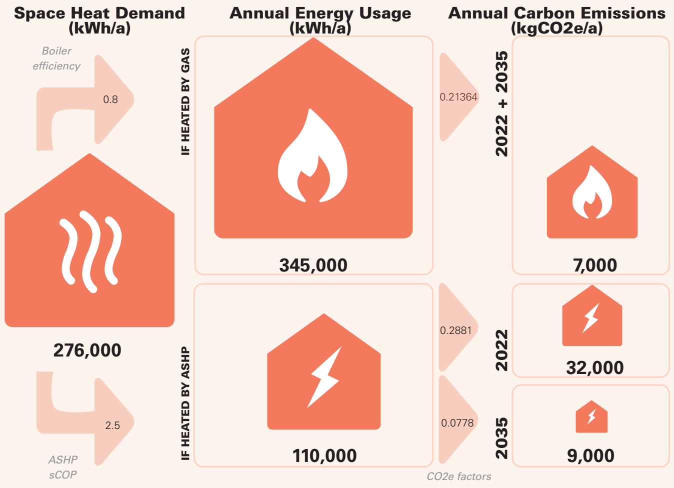
All gas hobs and ovens should be replaced with electric appliances. This not only reduces emissions associated with gas combustion, especially as the grid decarbonises, but has two other advantages. It reduces ventilation requirements and subsequent heat loss in winter. In summer, overheating risk is reduced because less heat is lost from electric induction hobs than gas hobs.

Heating appliance efficiencies
Boilers: 60-90% depending on age and set up
ASHPs: 250-350% depending on age and set up
Direct electric: 100%

Hot water storage & distribution efficiencies
Centralised storage: 30%
Local storage: 80%
No storage: 100%

Example hot water system efficiencies:
Boiler (80% efficient) + central storage = 24%
ASHP (250% efficient) + central storage = 81%
POU - direct electric with local storage = 80%
POU - direct electric at the tap = 100%

Comparing the carbon emissions of gas boilers vs ASHP, given the same space heat demand



See Appendix 6.07 for more information on each measure proposed

3.07 Fabric & ventilation measures

Wall insulation

Heat loss through walls is significant and thermal comfort is greatly affected by the thermal performance of walls. This study has good information on wall types, but limited information on the extent of insulation in cavity walls.

Our recommendations for wall insulation vary to suit the wall type.

Solid masonry walls: internal wall insulation (IWI) is most appropriate in buildings where retaining the external appearance is desired. Installing IWI is expensive and disruptive because floors and ceilings must be cut back and wall fittings removed and reinstated. In addition, insulation thicknesses must be limited to avoid moisture problems.

Cavity brick walls with no insulation: cavity wall insulation (CWI) can be applied to uninsulated cavities - subject to moisture risk analysis. CWI is relatively cheap but won't achieve very good U-Values due to the limited cavity sizes. Supplementing CWI with external wall insulation (EWI) is recommended where heat losses need to be reduced further. However EWI is more expensive because external fittings, services and rainwater goods must be removed and reinstated and roof eaves sometimes extended.

Cavity brick walls with partial fill insulation: these walls are problematic if the existing partial-fill insulation has come loose, which is often the case. In such instances, it is not possible to install either CWI or EWI due to thermal bypass rendering the insulation ineffective. IWI is the only option. The appropriate solution can only be established following site investigation.

Curtain walling: these can be replaced with new curtain walling with triple glazing and insulated frames and spandrel panels

Roof insulation

Heat loss through roofs is also significant because many existing roofs have either no insulation at all or insufficient, badly installed or damaged insulation. This study has limited information on roof insulation levels and it is therefore critical that the state of each school's existing roof insulation is established. Our recommendations for roof insulation vary to suit the roof type.

Pitched roofs, insulation at ceiling level: a wind-tightness membrane should be laid above 200-300mm thick mineral wool or woodfibre insulation. It is also important to install a vapour control layer (VCL) beneath the insulation, which may necessitate new plasterboard ceilings. The roof must be repaired if not in good condition.

Pitched roofs, insulation in line with rafters: this approach is riskier with regard to moisture because it is harder to ventilate the roof structure. Only install in line with rafters where required for internal spatial or aesthetic reasons.

Flat roofs in good condition: where roof coverings do not require replacing, insulation can be installed within/below the structural zone. However ventilation to the structure must be maintained and this is harder than with pitched roofs.

Flat roofs in poor condition: where roof coverings do require replacing and roofs can be made higher, take the opportunity to install insulation above the roof structure. Greater thicknesses can be achieved and the moisture risks of cold roofs are avoided.

Floor insulation

Heat loss through floors is typically less than through walls and roofs. Suspended timber floors benefit greatly from insulation between (and if possible below) the floor joists. However most schools' floors are solid concrete. Insulating solid concrete floors is very expensive and disruptive and therefore not recommended unless the building is undergoing complete renovation.

See Appendix 6.07 for more information on each measure proposed

Fabric & ventilation measures

Windows & doors

Windows and doors lose significant heat and have a big impact on thermal comfort. However they are expensive to replace and have high embodied carbon. We recommend therefore that single glazed windows be replaced. However, double glazing should only be replaced if in poor condition. All replacement or new windows should be triple glazed with insulated frames.

When windows/doors are replaced it can result in thermal bridges and an increased risk of condensation and mould growth on window/door reveals. Insulate reveals and improve ventilation to avoid these problems.

Airtightness improvements

Heat loss through infiltration varies enormously from building to building and can be significant. Airtightness improvements are best made alongside other fabric measures - for example when insulating roofs/walls or replacing windows. Existing service penetrations should also be taped.

See Appendix 6.07 for more information on each measure proposed

Ventilation

Almost all schools are naturally ventilated (ie openable windows) with mechanical extract to some rooms such as kitchens and WCs.

We recommend installing mechanical ventilation with heat recovery (MVHR) to allow the school to be properly ventilated without excessive heat loss through ventilation. The school layout and structure will dictate whether a centralised or decentralised system is most appropriate.

Summary

It must be noted that for all fabric measures, performance standards proposed in this HDP are higher than current building regulations demand for existing buildings.

In addition, work should be done following high energy efficiency design principles, ideally with professional advice from a passivhaus qualified architect or surveyor.

3.08 The packages of measures

For the purposes of modelling energy and carbon savings, we have divided the measures outlined above into four different packages. The box opposite summarises these packages. The following pages examine their impacts.

We then set out how the measures within these packages could be rolled out across the estate under Section 4: Delivery.

To reduce capital and running costs, we recommend that *Package 3: heating systems* be only carried out once a building's overall energy demand and peak loads has been reduced.

Package 1: the stand-alone measures
This package comprises simple, stand alone measures to reduce electricity and gas consumption:

- Energy monitoring and management
- LED lighting & lighting sensors
- POU hot water
- All electric kitchen
- Photovoltaics

Package 2: immediate fabric measures
This package targets very poorly performing walls, windows and roofs that are relatively easy to improve:

- Insulate uninsulated cavity walls
- Insulate uninsulated roofs
- Replace single glazing with triple glazing

Package 3: heating systems
This package eliminates the use of fossil fuels for heating and hot water:

- replace boilers with ASHPs
- replace heating pipework and emitters (if required)
- insulate all pipes

Package 4: pragmatic fabric & services retrofit
This package comprises a whole-building holistic retrofit that encompasses the easier fabric measures:

- Target EUI of 75kWh/m2.yr
- All Package 1 measures
- All Package 3 measures

  +
- Insulate uninsulated cavity walls
- Replace single glazing & end-of life double glazing with triple glazing
- Insulate all roofs (replace if required)
- Improve airtightness throughout
- Install MVHR throughout

Package 5: ambitious fabric & services retrofit
This package comprises a whole-building holistic retrofit that encompasses deeper fabric measures:

- Target EUI of 65kWh/m2.yr
- All Package 4 measures

  +
- Insulate all walls
- Replace all windows with triple glazing

3.09 Package 1: the standalone measures

This package comprises simple measures to reduce both electricity and gas consumption. Generally, these measures can be carried out across an entire school independent of other measures, although PV and POU have some constraints/opportunities.

Energy monitoring and management: this includes all the measures outlined under 'Energy monitoring and management' above.

LED lighting & lighting sensors: all non LED lighting is replaced with LEDs. Movement and daylight sensors are installed inside and out.

Point-of-use (POU) hot water: all centralised hot water systems are replaced by POU, served by direct electric.

Kitchen electrification: all gas hobs and ovens are replaced by direct electric.

Photovoltaics: PV panels are installed on all flat roofs and on any pitched roofs that face south, south-east or south-west. Roofs need to be surveyed and assessed to ensure they are structurally sound, in good condition and will not be affected externally by later insulation measures.

Draughtproofing: of very leaky windows/doors and service penetrations

See Appendix for modelling assumptions

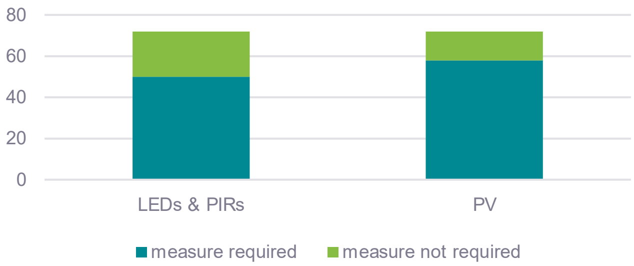
Frequency

The estimated impact of Package 1 measures in terms of energy, carbon and cost, depends hugely on two things:

Firstly, the energy reductions per square metre achieved by each measure. Our modelling assumptions are outlined in greater detail in the appendix.

Secondly, the extent to which these measures can be applied across the estate. This has been evaluated on a school-by-school basis. All of the schools can implement energy monitoring and management. It is also assumed that all of the schools can benefit from POU hot water, electrified kitchens and simple draught proofing. However, some schools already have LED, PIRs or PV and therefore require no improvements. See graph below.

No. of schools where LEDs / PIRs and PV need installing

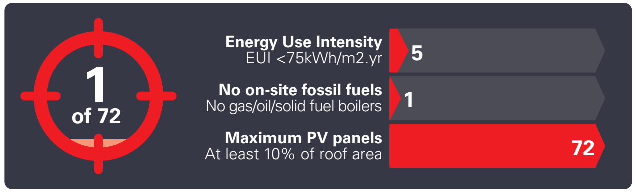


See Appendix for frequency assumptions

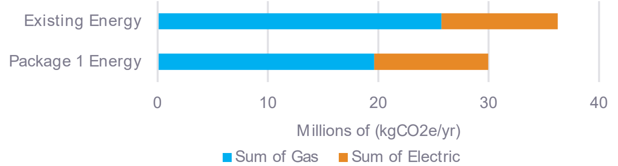
Impacts

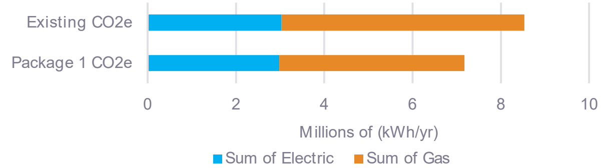
If Package 1 measures are implemented across the entire estate **one school would be zero carbon** (Ethelred). Annual carbon emissions would reduce as well as annual energy costs.

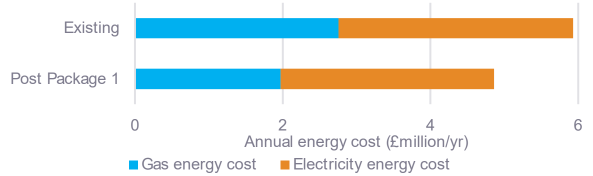
How many schools would be net-zero?



What would the estate's energy usage, carbon emissions, and energy bills be?







Running cost estimate for energy consumption (excl standing charges) based on 2022 prices - £0.107/kWh for gas, £0.302/kWh for electricity

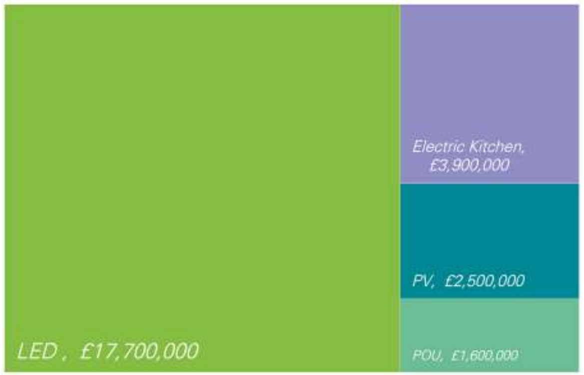
3.09 Package 1: the standalone measures

EUI and CO_2e emissions

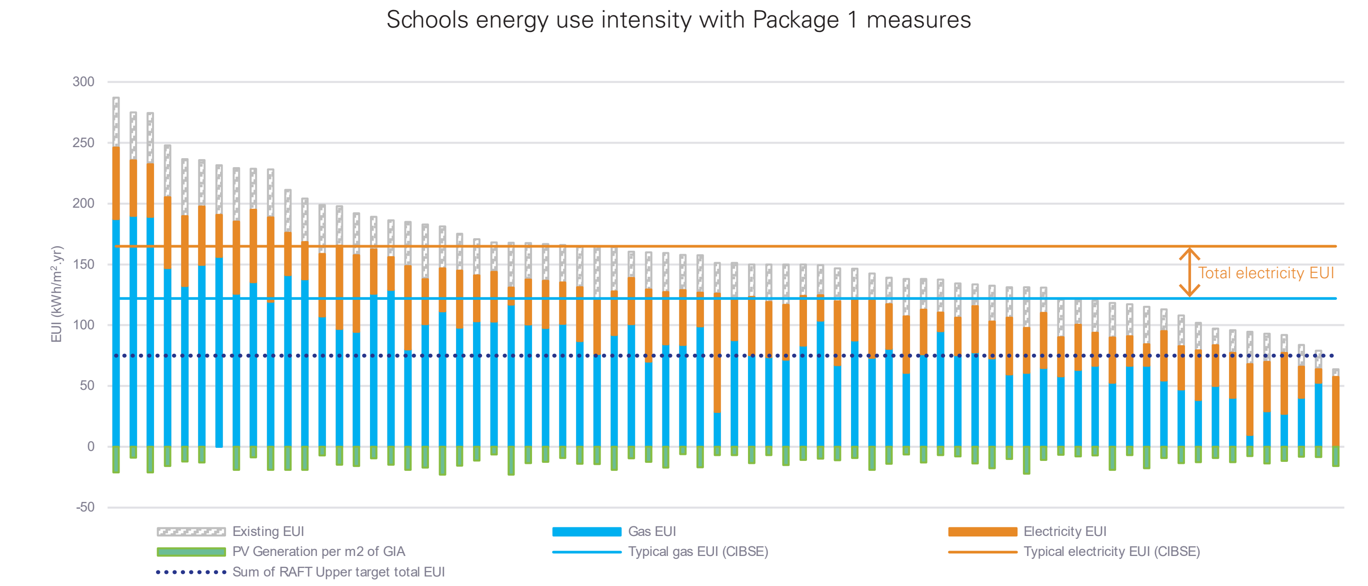
The bar charts opposite show the schools' gas and electricity EUI and carbon emissions following implementation of Package 1 measures across the estate. All of the schools' carbon emissions have reduced as a fairly consistent proportion of their existing emissions. All of the schools' EUIs have reduced and one meets the 75kWh/m².yr target with two more close. No school's PV generation comes close to meeting energy consumption.

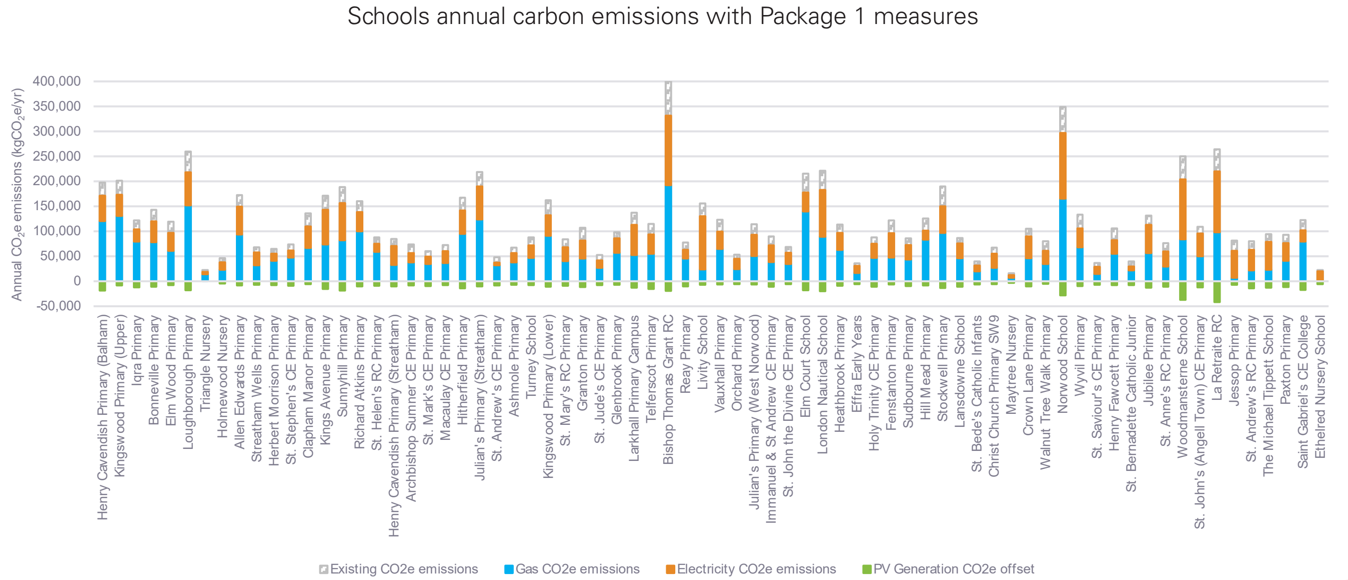
Upfront construction costs - £22.5m

The chart below shows the breakdown, with LEDs being the biggest expenditure because of the sheer number of light fittings required. However LEDs are considered to have a relatively short payback period.



See Appendix for more detail on costs





3.10 Package 2: immediate fabric measures

This package targets the worst performing elements of the building fabric, which can be improved 'relatively' easily and - windows aside - relatively cheaply. Tackling these areas can significantly reduce heat loss and improve building comfort. Consequently, these sorts of works are often done as 'stand alone' measures. However, an holistic risk assessment of the building is required before any measures.

Cavity Walls: Not all cavity walls are suitable for cavity wall insulation. Also, measures may be required to reduce moisture penetration from the outside including repointing brick walls, applying hydrophobising brick cream and fixing leaking rainwater goods.

Uninsulated roofs: Vapour control layers and effective roof ventilation are required to minimise moisture risk within the roof structure.

Single glazing: Improving leaky windows (and roofs) can substantially reduce background air leakage. Additional internal mechanical ventilation may be required to avoid risk of excessive internal humidity levels.

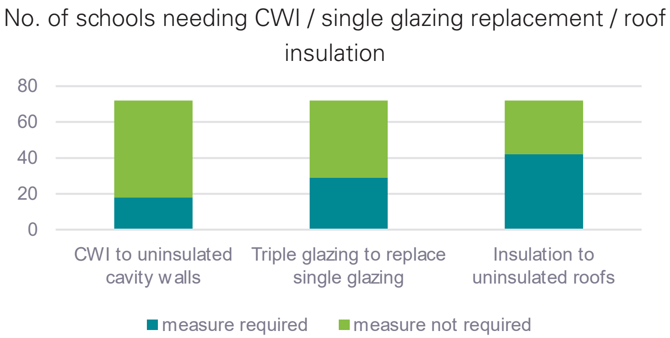
Ideally these measures would be undertaken as part of a whole-building retrofit (Package 4), but they can be a useful 'phase 1'.

See Appendix for modelling assumptions

Frequency

Across the estate there are 72 schools and 321 individual buildings. These measures are applied at a building level. This raises two issues: Firstly, the impact of Package 2 depends hugely on the extent to which the measures are applied across the estate. Only some of the buildings have uninsulated cavity walls, most roofs have at least some insulation, and few buildings have a lot of single glazing. The chart below indicates our estimate of the likely magnitude of Package 2 measures across the estate.

Secondly, whilst the works are done at a 'building level', our calculations are carried out a 'school level': energy savings are subtracted from each school's existing energy usage. This masks the fact that energy consumption will vary enormously between buildings within a school - especially for heating.

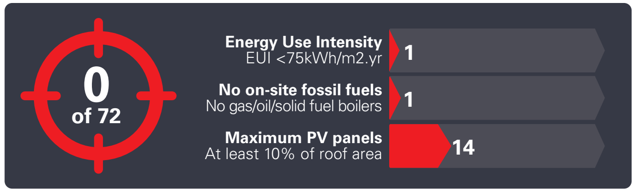


See Appendix for frequency assumptions

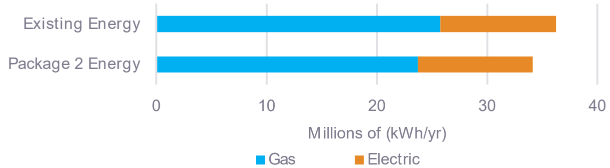
Impacts

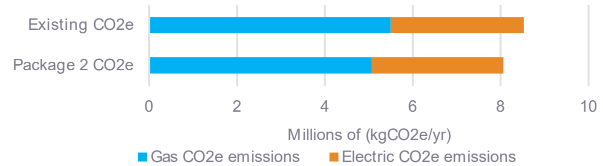
If Package 2 measures are implemented across the entire estate **no schools would be zero carbon.** Annual carbon emissions would reduce, as would energy costs, but not as much as with Package 1 measures.

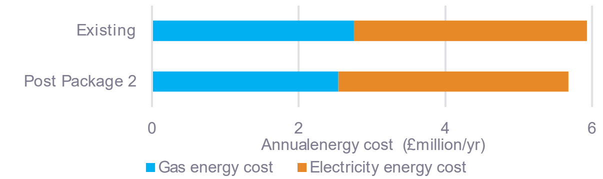
How many schools would be net-zero?



What would the estate's energy usage, carbon emissions, and energy bills be?







Running cost estimate for energy consumption (excl standing charges) based on 2022 prices - £0.107/kWh for gas, £0.302/kWh for electricity

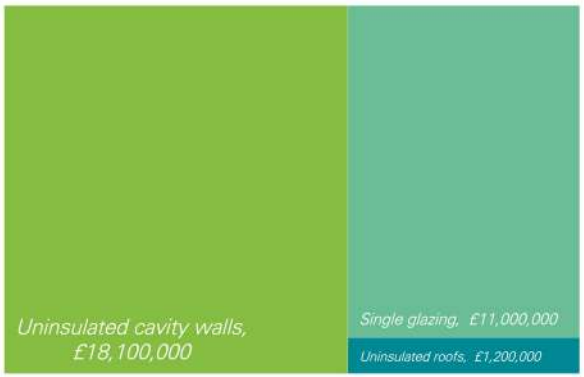
3.10 Package 2: immediate fabric measures

EUI and CO_2e emissions

The reductions in carbon emissions that can be achieved varies greatly by school - because the extent of uninsulated cavity walls, uninsulated roofs and single glazing that can be upgraded varies from school to school. Most of the energy reductions are in gas, except for schools partially heated by ASHPs. These charts show which schools would benefit most from Package 2 measures.

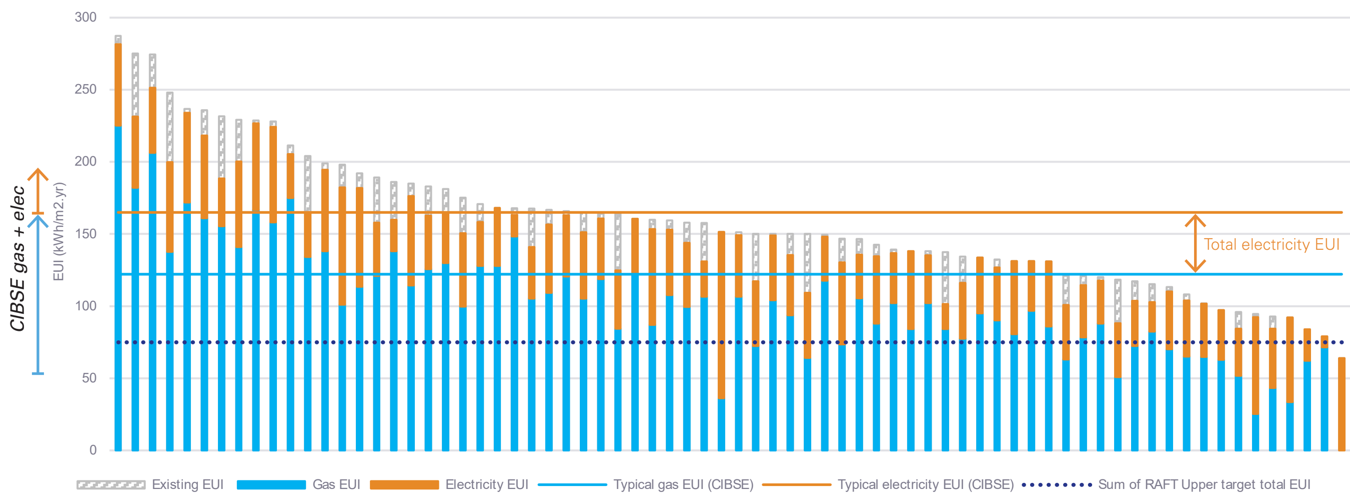
Upfront construction costs - £17.1m

The chart below shows the breakdown, with replacing single glazing being the biggest expenditure due to high window costs.

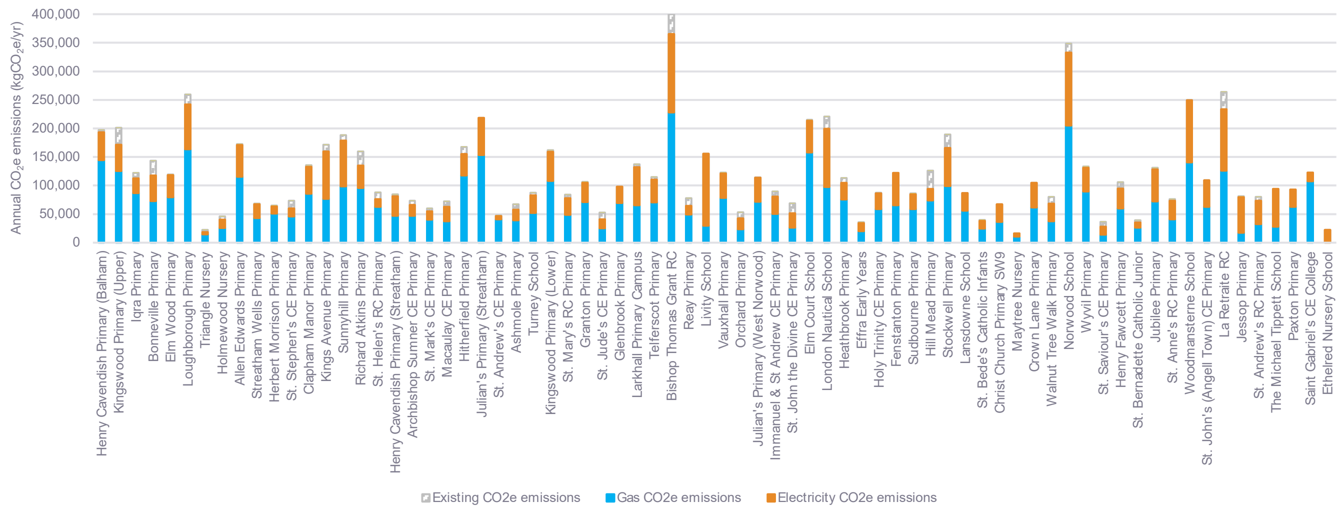


See Appendix for more detail on costs

Schools energy use intensity with Package 2 measures



Schools annual carbon emissions with Package 2 measures



3.11 Package 3: heating systems

This package eliminates the use of fossil fuels on school sites. **Gas boilers are replaced with ASHPs**, installed externally. The superior efficiency of ASHPs means carbon emissions can be greatly reduced even if heat demand isn't.

Replacing boilers with ASHPs can be done as a 'stand alone' measure, but they are are best installed **after measures to reduce heat and electrical loads**. Also the **heating pipework and emitters often need upgrading.** If not, there is a risk that ASHPs will run sub-optimally, occupant comfort may diminish, utility bills may increase and electricity infrastructure may need upgrading.

For these reasons - in buildings with high space heat demands and high peak heat loads - we recommend that ASHPs are installed only after the implementation of Packages 1 and 2, and ideally as part of a whole-building retrofit (Package 4).

Note that Package 3 does not include shifting to POU hot water. It assumes hot water is still delivered via a central system, serviced by ASHPs. POU hot water would be installed under Packages 1,4 and 5.

See Appendix for modelling assumptions

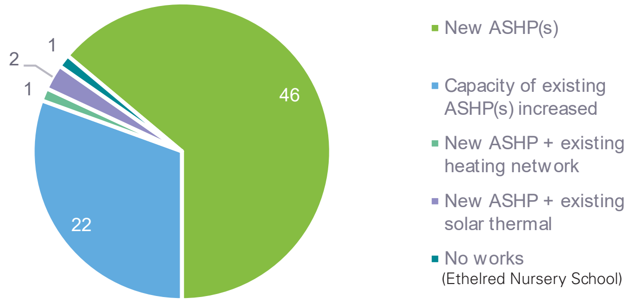
Frequency

As with Package 2, Package 3 is implemented at a building level, although the calculations are carried out at a school level.

All of the schools have gas boilers. Some of the schools also have ASHPs serving some of their buildings, access to heat networks or (dysfunctional) solar thermal systems. Under Package 3, all school boilers are replaced - and consequently, all schools except Ethelred Nursery School are affected by these works. However, where schools already have ASHPs, this is a case of increasing capacity.

Without detailed investigation, it is impossible to judge which schools' heating pipework and emitters could be retained, and which must be replaced. This will depend on peak heat loads and the condition of the existing systems.

Proposed ASHP measure frequency by number of schools

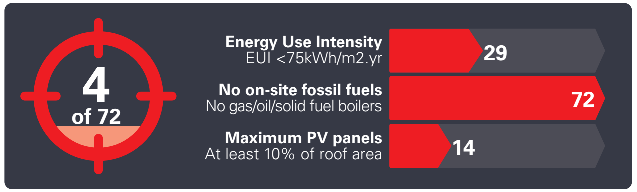


See Appendix for frequency assumptions

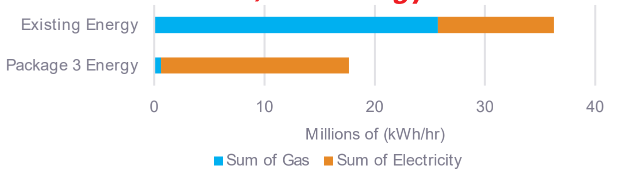
Impacts

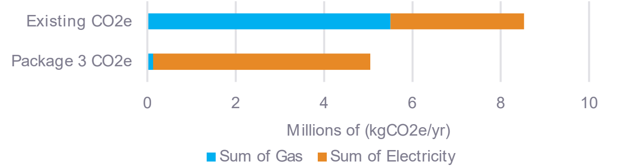
If Package 3 measures were implemented across the entire estate **4 schools would be zero carbon** - these being schools that already have PV and a relatively low EUI. Energy costs would reduce but not as much as Package 1, due to higher electricity costs compared to gas.

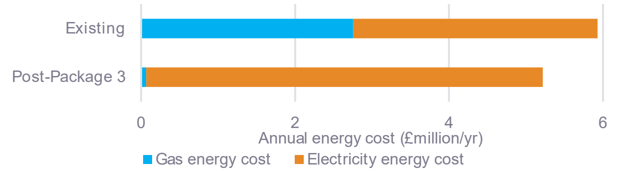
How many schools would be net-zero?



What would the estate's energy usage, carbon emissions, and energy bills be?







Running cost estimate for energy consumption (excl standing charges) based on 2022 prices - £0.107/kWh for gas, £0.302/kWh for electricity

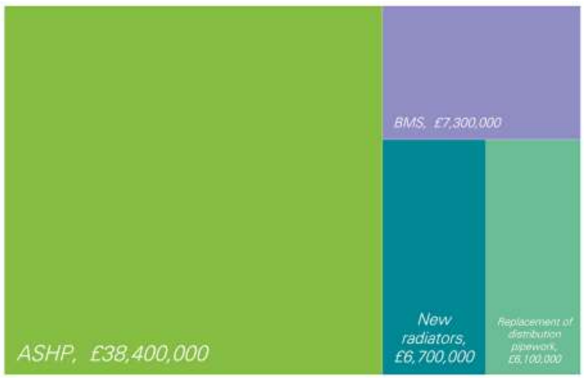
3.11 Package 3: heating systems

EUI and CO_2e emissions

The reductions in carbon emissions and EUI are substantial and are largely proportional to existing emissions and EUI. Over 30 schools start to meet the EUI target simply because ASHPs are so much more energy efficient than gas boilers. The outlier is Livity School which has an existing ASHP and very high existing electricity EUI.

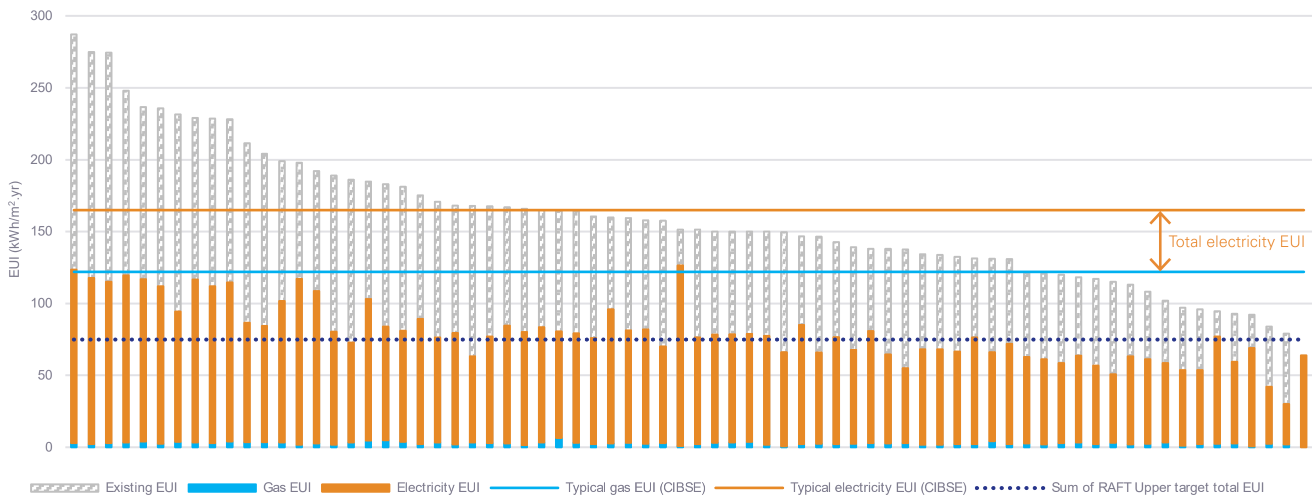
Upfront construction costs - £54.3m

The upfront construction costs are around £750k per school and are dominated by ASHPs - a cost that can come down if ASHP sizes are reduced by measures to lower peak heat loads. For comparison, under Package 4 (see Section 3.13) ASHP costs are £10m lower. The introduction of BMS systems, new radiators and pipework is not insignificant and those costs will depend hugely on the condition of the existing system.

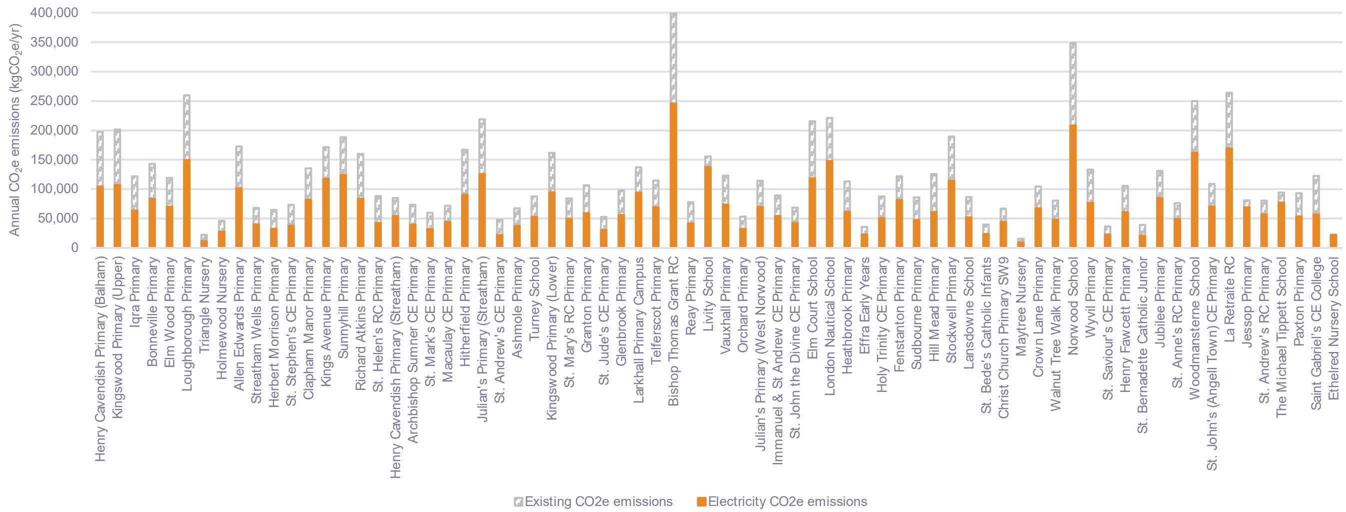


See Appendix for more detail on costs

Schools energy use intensity with Package 3 measures



Schools annual carbon emissions with Package 3 measures



3.12 Packages 1,2,3 combined

This solution combines all the measures of Packages 1,2 and 3. On site PV is introduced, on-site fossil fuels removed and simple fabric and other energy efficiency measures are included:

- Energy management
- LEDs & PIR
- POU
- PV
- All electric kitchens
- Draught proofing leaky windows/doors

  +
- ASHPs to replace gas boilers

  +
- Insulate uninsulated cavity walls
- Replace single glazing & end-of life double glazing with triple glazing
- Insulate uninsulated roofs

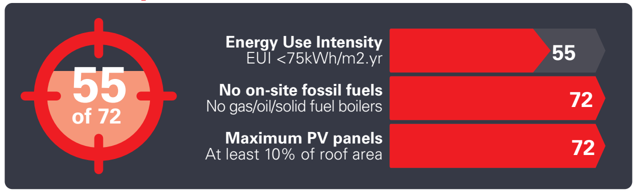
Frequency

The frequency of each measure has already been discussed under Package 1, Package 2 and Package 3 above.

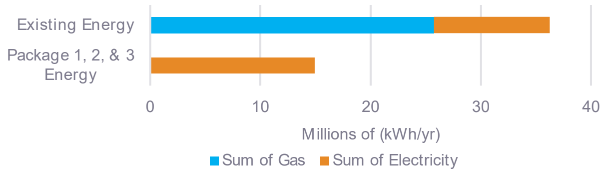
Impacts

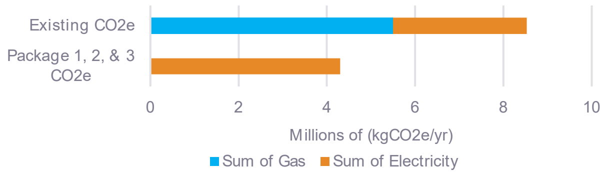
If Package 1,2&3 measures were combined and implemented across the entire estate **all but 17 schools would be net zero**. Total energy use is reduced by 60% and carbon emissions halved. Savings in energy bills are over £1.5m/yr.

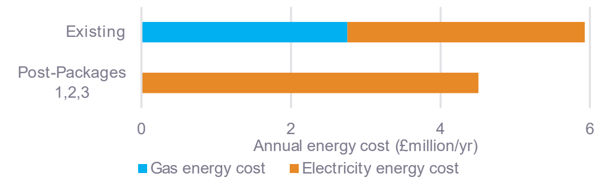
How many schools would be net-zero?



What would the estate's energy usage, carbon emissions, and energy bills be?







Running cost estimate for energy consumption (excl standing charges) based on 2022 prices - £0.107/kWh for gas, £0.302/kWh for electricity

3.12 Packages 1,2,3 combined

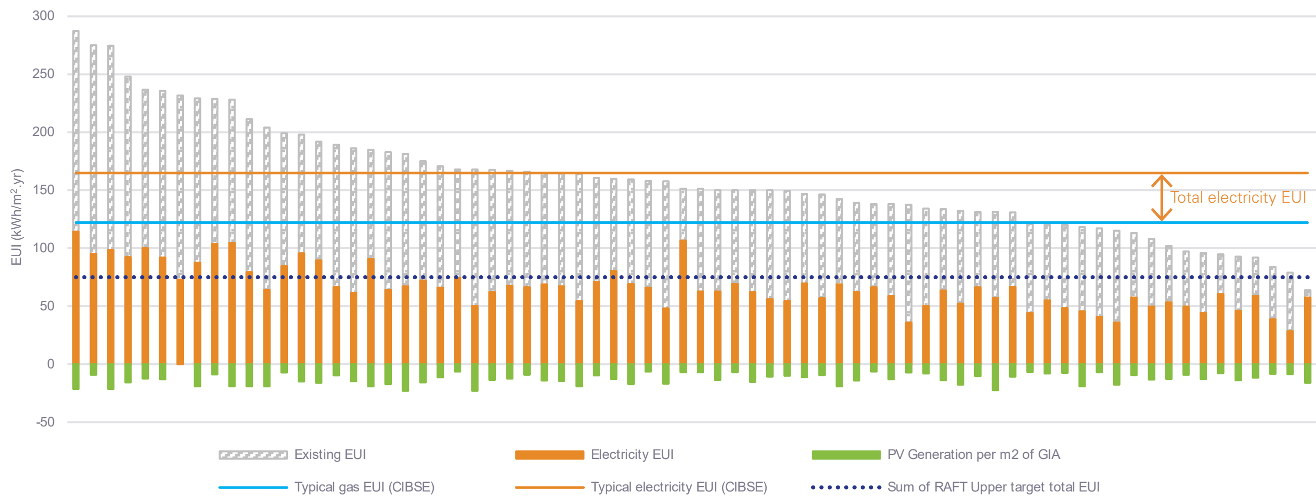
EUI and CO_2e emissions

The reductions in carbon emissions and EUI are substantial with the majority of schools meeting the net-zero EUI target.

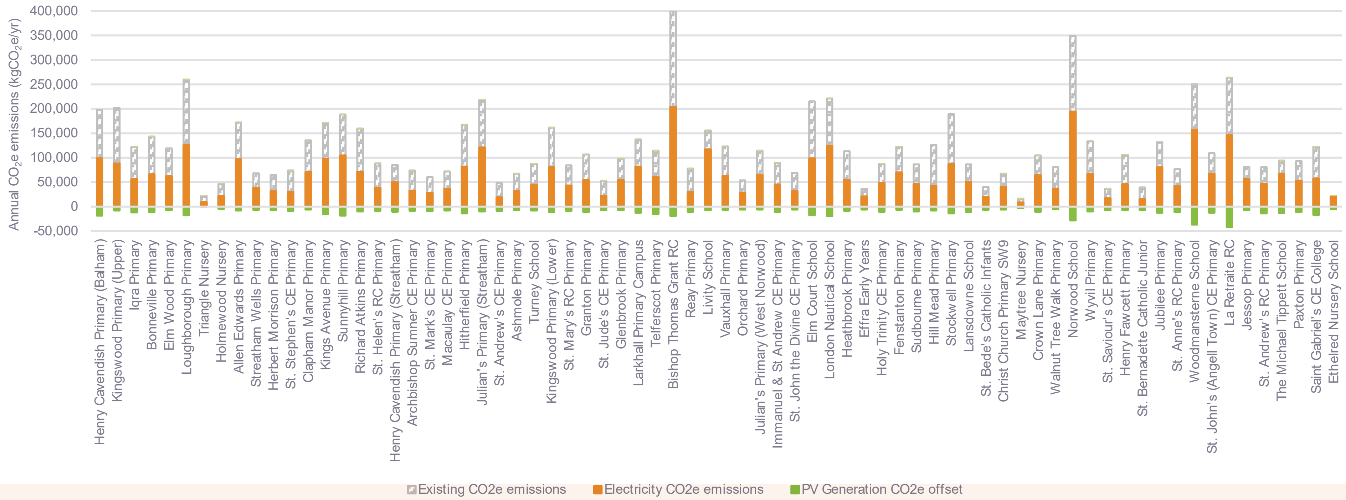
Upfront construction costs - £90.8m

The upfront construction costs are around £1.25m per school. ASHPs amount to over a third of the total costs, with LEDs and single glazing replacement being the next most costly measures.

Schools energy use intensity with Packages 1,2,3 combined measures



Schools annual carbon emissions with Packages 1,2,3 combined measures



3.13 Package 4: pragmatic fabric & services retrofit

This package comprises a whole-building holistic retrofit applied on a building by building basis. Walls and floors aren't insulated to reduce costs and disruption.

This package brings significant benefits including big energy and carbon reductions, reduced running costs, building resilience, and improved occupant health and comfort (due primarily to good ventilation).

The measures include:

- Target EUI of 75kWh/m2.yr
- Energy management
- LEDs & PIR
- POU
- PV
- All electric kitchens
- ASHPs to replace gas boilers

+

- Insulate uninsulated cavity walls
- Replace single glazing & end-of life double glazing with triple glazing
- Insulate all roofs (replace if required)
- Improve airtightness
- MVHR throughout

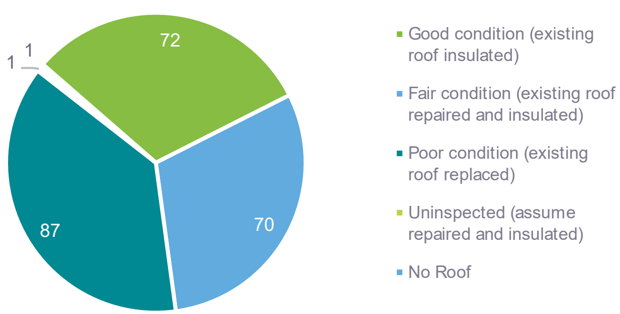
See Appendix for modelling assumptions

Frequency

The analysis assumes ALL buildings are upgraded with a Package 4 retrofit to achieve an EUI of 75kWh/m^2.yr or less. However, the extent of measures carried out varies from building to building. For example, the type of roof insulation, or the extent of LED installation. This has been taken into account when assessing costs.

The frequency of measures that fall under Packages 1,2 or 3 have been analysed above. Package 4 demands improved roof insulation to all roofs. The insulation strategy will depend on the type and condition of the roof. Where flat roofs are in poor condition, it is assumed insulation is installed above the structure along with a new roof covering. In all other situations, the insulation is installed beneath the roof structure.

Roof condition across estate by number of buildings

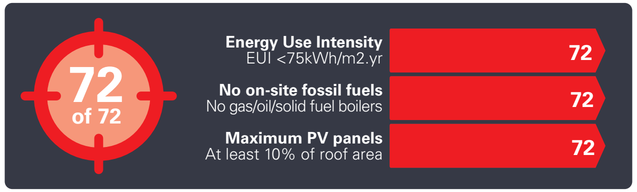


See Appendix for frequency assumptions

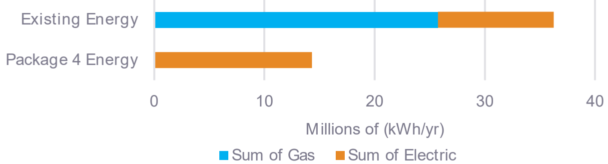
Impacts

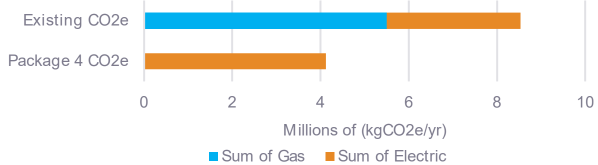
If Package 4 measures were implemented across the entire estate **all schools could be zero carbon.**

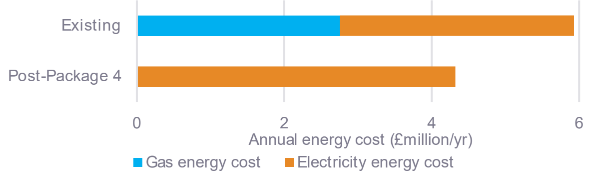
How many schools would be net-zero?



What would the estate's energy usage, carbon emissions, and energy bills be?







Running cost estimate for energy consumption (excl standing charges) based on 2022 prices - £0.107/kWh for gas, £0.302/kWh for electricity

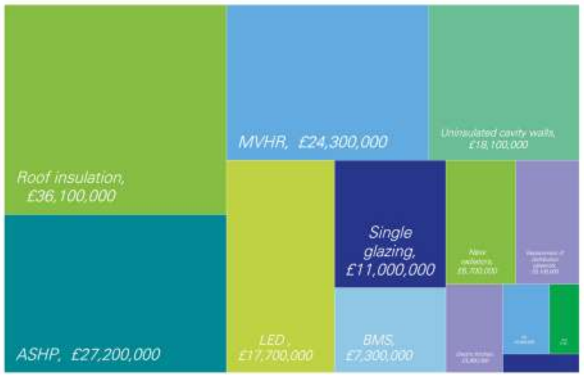
3.13 Package 4: full fabric & services retrofit

EUI and CO_2e emissions

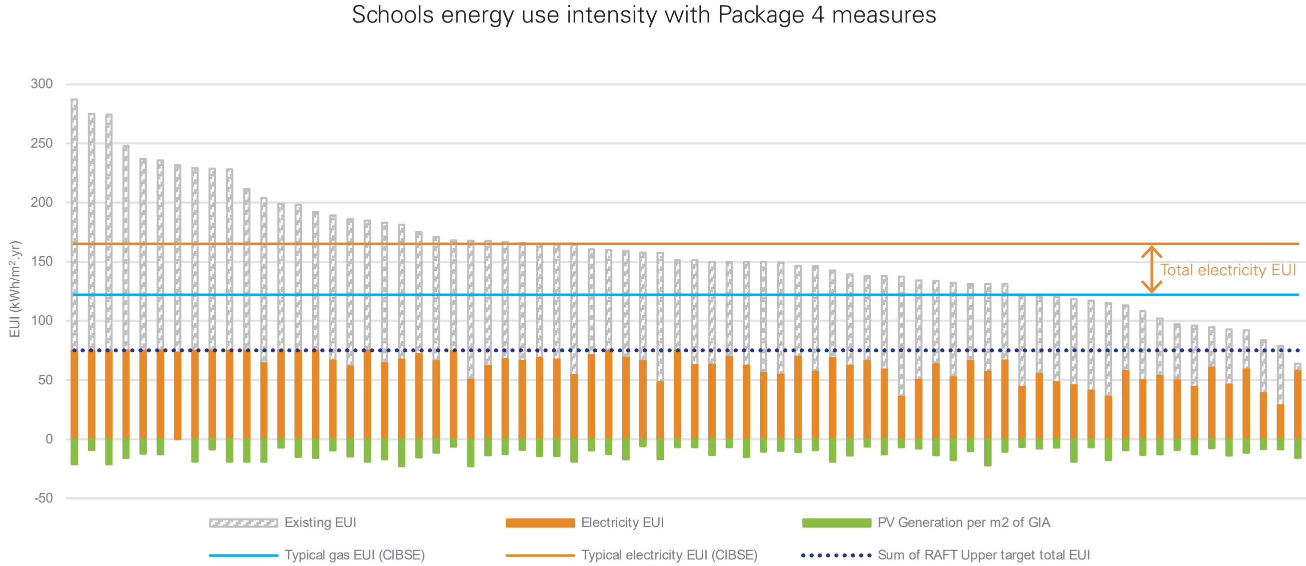
Every school should be able to achieve the EUI target with Package 4 measures, although the EUI of different buildings across a school will vary. The percentage of emission reductions vary from school to school.

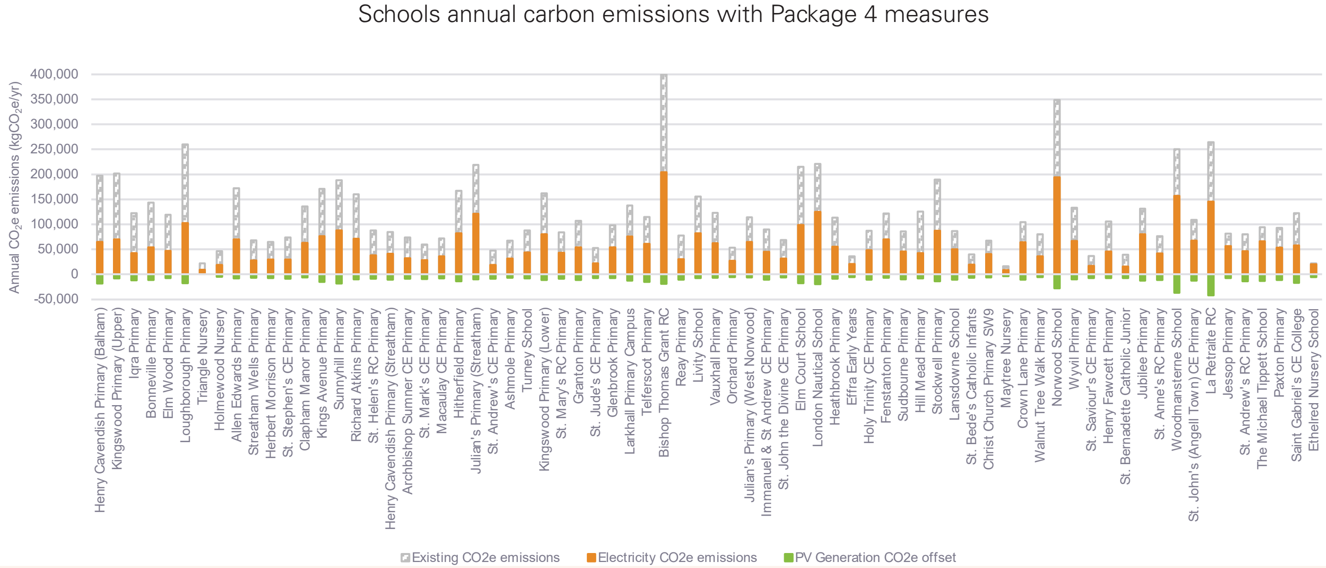
Upfront construction costs - £145m

Package 4 costs around £2m per school. Roof insulation is the greatest single item because we've assumed every roof needs its insulation improved. This cost will reduce if some roofs can be excluded from upgrades following proper roof insulation surveys. Heating and ventilation system costs are the next biggest items. MVHR is critical to achieving good IAQ and has the added advantage of reducing heat loss through ventilation.



See Appendix for more detail on costs





3.14 Package 5: ambitious fabric & services retrofit

This package is similar to Package 4 but includes additional measures to achieve a more ambitious EUI target of 65kWh/m2.yr

These additional measures are:

- Insulate all walls
- Replace all windows with triple glazing

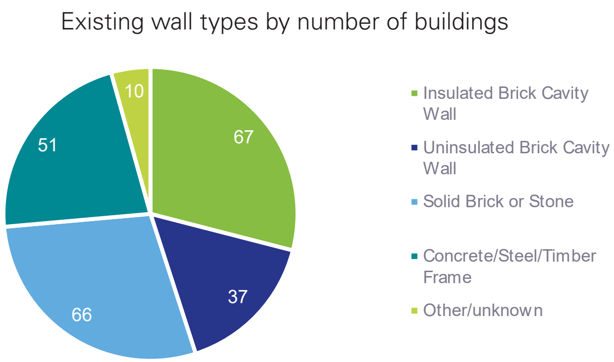
This approach is useful for very inefficient buildings where the EUI target cannot be met with a Package 4 level of retrofit only. Package 5 is also appropriate for buildings undergoing substantial renovation due to organisational or spatial reasons, or because the whole building envelope is in very poor condition.

Frequency

The analysis presented on this and the following page assumes ALL buildings are upgraded with Package 5. A flat EUI rate of 65kWh/m2.yr is deemed to be achieved across the estate's entire building stock.

The extent of Package 1&3 measures remain the same as noted above. However, fabric measures are applied to all roofs, walls and windows.

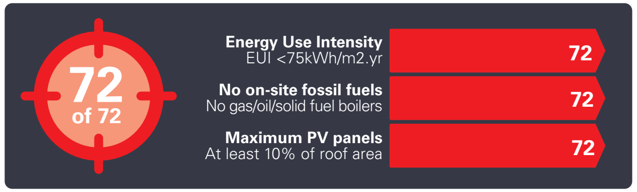
All roofs are insulated in a similar manner to Package 4. All windows are replaced with triple glazing. Walls are treated differently depending on the wall type. For the purposes of this analysis, uninsulated cavity walls receive CWI and external wall insulation. Solid walls and partially insulated cavity walls receive internal wall insulation.



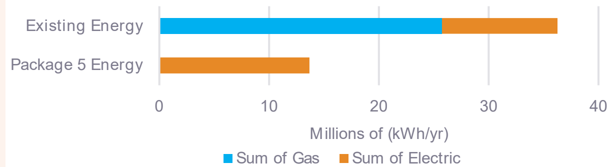
Impacts

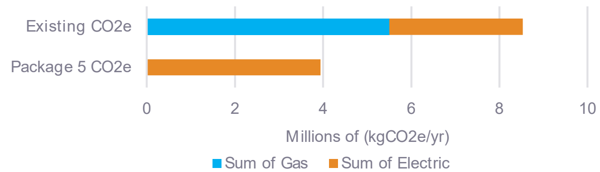
If Package 5 measures were implemented across the entire estate **all schools could be zero carbon.**

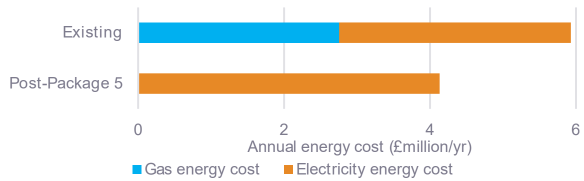
How many schools would be net-zero?



What would the estate's energy usage, carbon emissions, and energy bills be?







Running cost estimate for energy consumption (excl standing charges) based on 2022 prices - £0.107/kWh for gas, £0.302/kWh for electricity

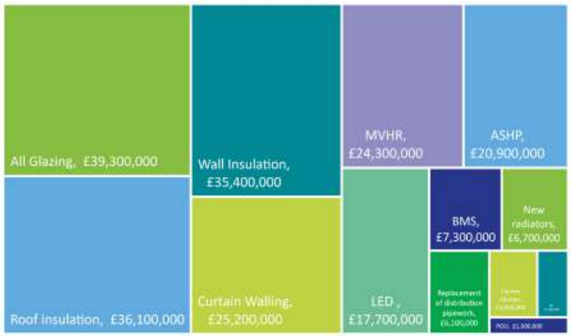
3.14 Package 5: ambitious fabric & services retrofit

EUI & carbon reductions

Every school is able to achieve the EUI target with Package 5 measures, although the EUI of different buildings across a school will vary. The percentage of emission reductions vary from school to school.

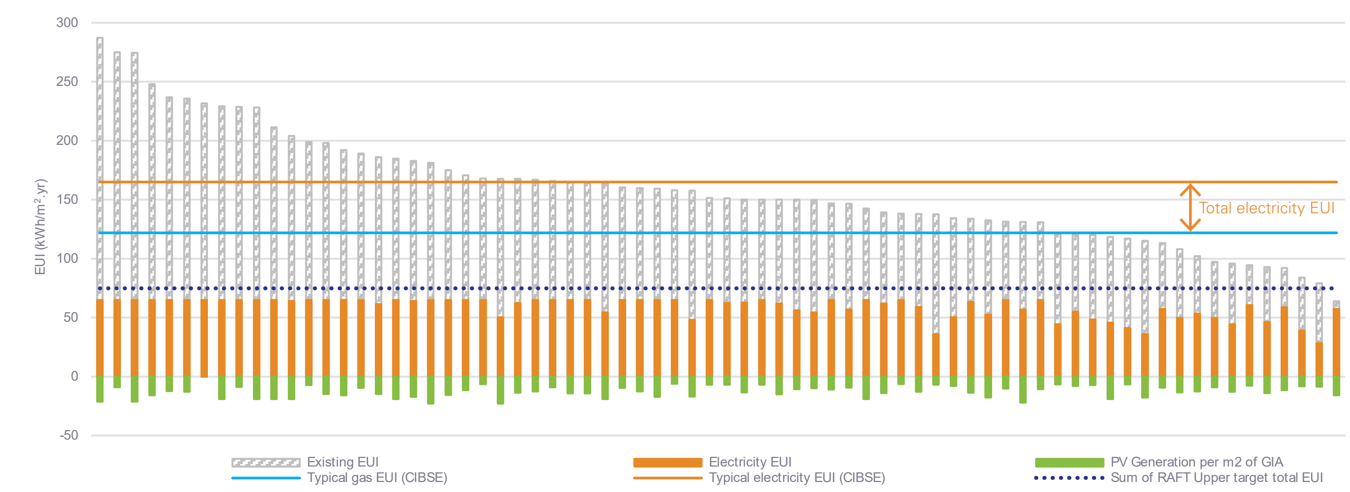
Upfront construction costs - £215m

This is the most expensive of all the different Packages costing around £3m per school.

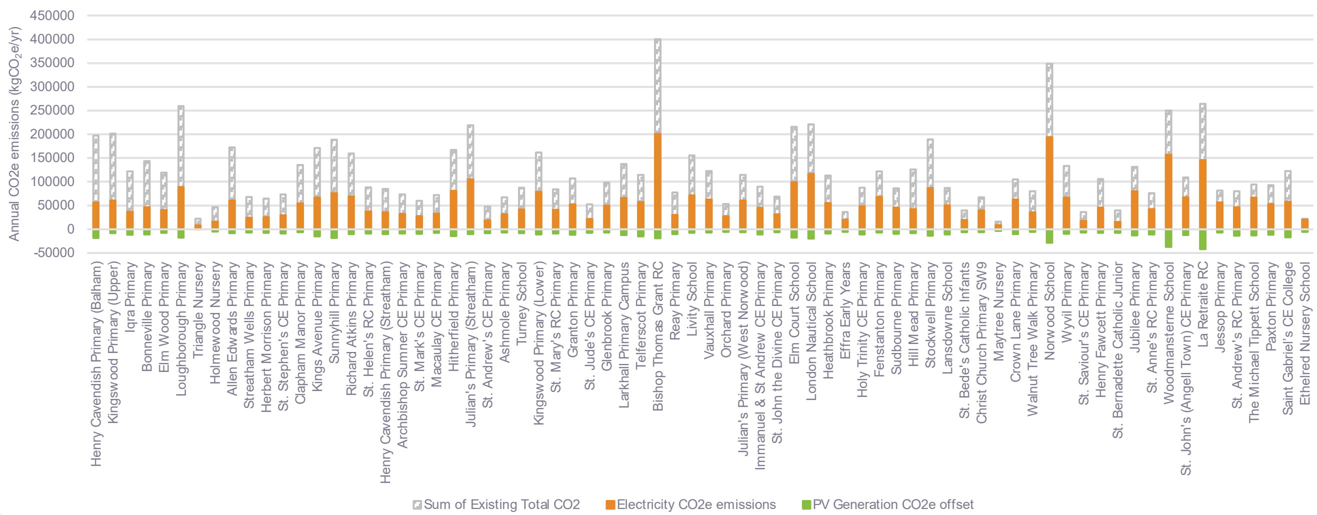


See Appendix for more detail on costs

Schools energy use intensity with Package 5 measures



Schools annual carbon emissions with Package 5 measures



3.15 Comparison of packages - general impacts

Comparison of impacts

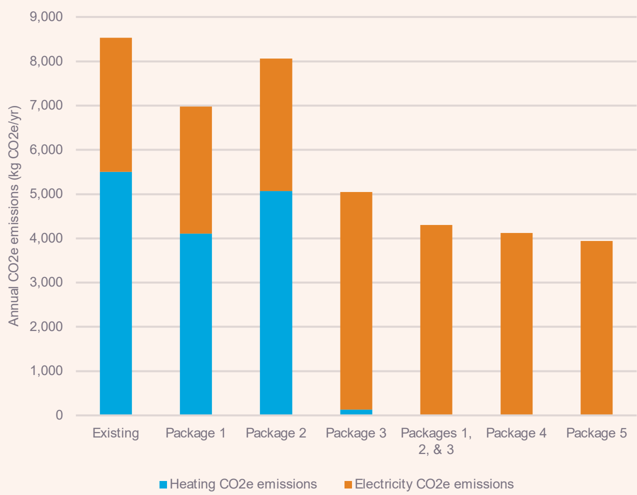
It is useful to compare the packages side by side with regard to different impacts:

Packages 1 & 2, if enacted alone reduce energy/carbon slightly but no schools meet the net-zero target. Package 3 has a bigger impact on emissions and energy but costs remain high and few schools meet the net-zero target. Packages 4&5 provide the biggest savings in energy, carbon and bills. However the combined Packages 1,2,3 also perform well for a lower capital cost.

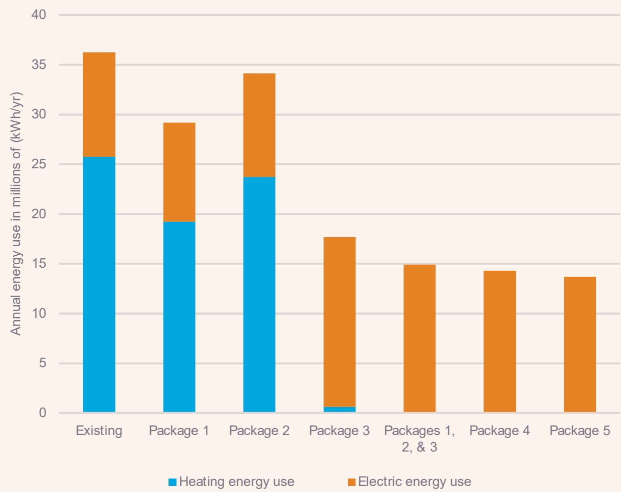
It must be noted that whilst the findings are presented by school, Packages 2,3 and 4 are applied to individual buildings, rather than the school as a whole. Consequently, a given school will have different measures applied to different buildings. Also, a school may have some buildings that meet the EUI target of 75kWh/m^2.yr and others that do not.

Number of schools achieving Zero Carbon target

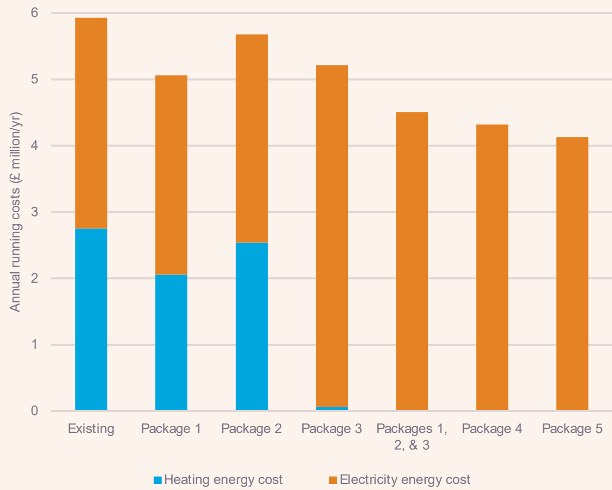
Retrofit package annual CO2e emissions



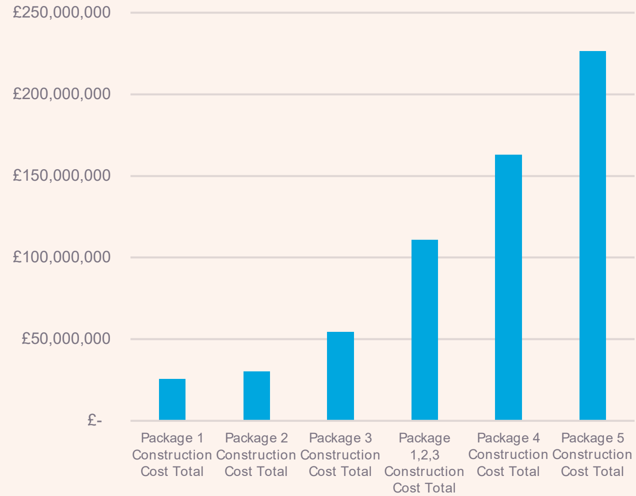
Retrofit package annual energy use



Current vs post-package energy costs across estate



Upfront costs



3.16 Comparison of packages - peak loads

As discussed above, it is essential to reduce peak heating loads before introducing ASHPs for a number of reasons including:

- to limit the need for electricity infrastructure upgrades
- to reduce the costs of the ASHP itself
- to ensure the building can still be heated adequately with low temperature water flowing through radiators

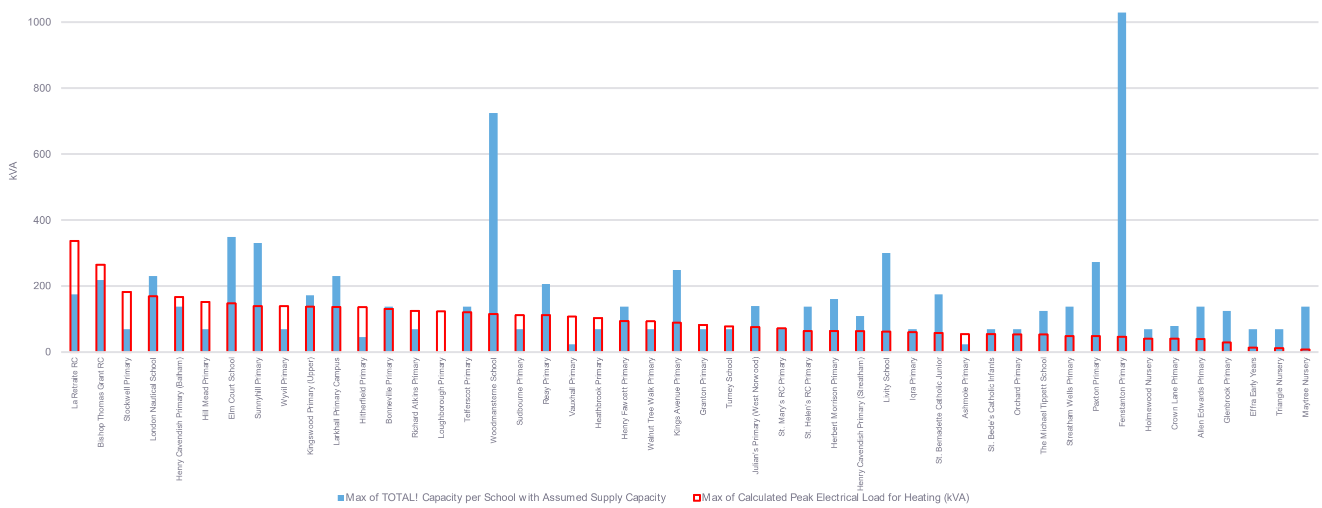
Peak loads & electrical capacity

Establishing whether introducing ASHPs into the 72 Lambeth schools will cause capacity issues is not possible. We only have existing electrical capacity data for 48 schools. In addition, whilst we can estimate peak heat loads using the Salix calculator, we have not estimated peak additional electrical loads resulting from electric kitchens and hot water.

That said, if - for those 48 schools - we compare peak electrical capacity with existing peak electrical loads from heating along, we can see that over a third have insufficient capacity - and that's before one adds in the schools' non-heat electrical loads. It is for this reason that reducing peak heat loads is so important.

The cost of DNO upgrades is currently bourne by schools although it may be bourne by DNOs in future.

School's total known electrical capacity compared to estimated peak electrical demand from heating



3.16 Comparison of packages - peak loads

Peak loads & ASHP costs

The table below compares the cost of ASHP install across the school estate for different Packages. If no attempt is made to reduce peak heating loads (Package 3), the total ASHP cost is £3-£15m higher - simply because of larger sized ASHP units.

	ASHP install cost
Package 3	£34.4m
Packages 1,2&3	£31.4m
Package 4	£24.2m
Package 5	£18.5m

It is always worth balancing the cost of additional thermal efficiency measures against the cost of additional ASHP capacity.

Peak loads & thermal comfort

ASHPs are most efficient when flow temperatures are low. With this in mind it is recommended that peak heat loads are reduced to below 60W/m². Otherwise, unreasonably large radiators will be required to provide adequate heat. Existing heating systems often have flow temperatures of 60-80oC compared to an ideal flow temperature of 35oC for an ASHP. If the flow temperature is halved and an existing radiator is sized correctly, that radiator will need to be doubled in size to produce sufficient heat. Even if higher flow temperatures of 50oC are used, correctly sized radiators will need to be increased in size if peak heat loads aren't reduced.

The histograms opposite show the impact on peak heat load on the schools across the estate under the various Packages.

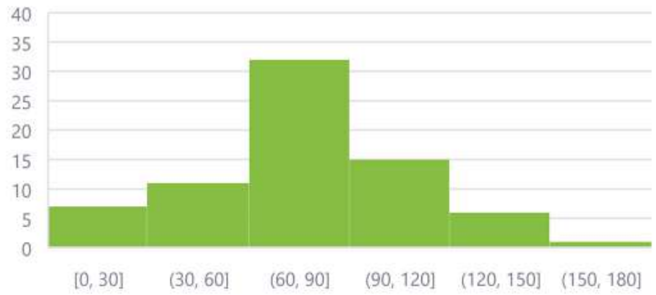
Currently, 80% of schools have peak heat loads higher than 60W/m². This will cause big problems if ASHPs are installed without reducing the loads - as would be the case under a roll-out of just Package 3. If there is insufficient space for very large radiators, these schools will suffer from inadequate heating on the coldest days of the year.

With the very modest fabric improvements of Package 2, peak heat loads are reduced across the board. The number of schools with peak heat loads higher than 60W/m2 reduces by only a few but the number of schools with very high loads/m2 reduces by a larger number.

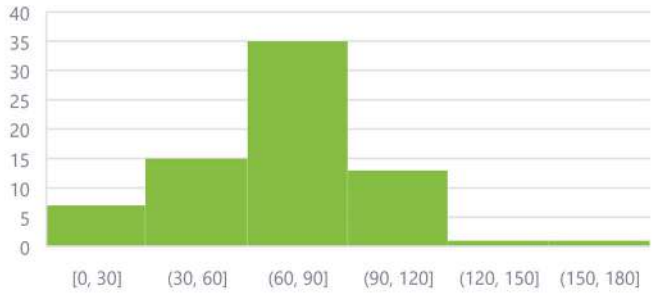
By contrast, if every school receives a Package 4 level retrofit, less than half the schools will suffer from uncomfortably high peak heat loads.

Whilst the net-zero target focuses on EUI, eliminating fossil fuels and introducing PV, it is worth bearing in mind that peak heat load is also very important.

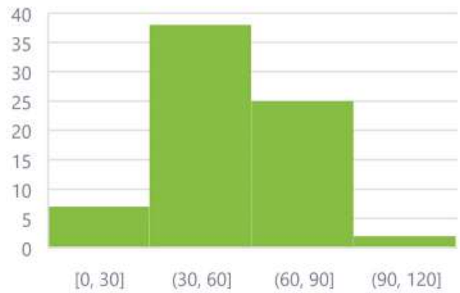
Existing Peak Heat Load/sqm (W/sqm)



Post package 2 Peak Heat Load/sqm (W/sqm)



Post package 4 Peak Heat Load/sqm (W/sqm)



3.17 The whole estate solution - a blend of packages

We have examined how different packages of measures can be applied across the whole estate. However, not all schools - nor buildings - need all of the measures to achieve the net-zero target. A blended approach is proposed, applying only the packages applicable and necessary for each school to achieve net-zero.

Package 1 measures are necessary in all schools. Electric kitchens are essential for eliminating on-site fossil fuels. PVs are essential for meeting the net-zero target. The other measures are basic energy reduction measures required to bring down a school's overall EUI.

Package 2 measures are applicable only to those schools with uninsulated cavity walls, uninsulated roofs and single glazing. We have assumed all 1945-76 buildings have uninsulated cavities and 10% of all pre-2003 roofs are uninsulated - unless the school's existing gas usage is so low it implies their walls and roofs are insulated. The extent of single glazing is known from condition surveys.

Package 3 is applicable to all schools with gas boilers which must be removed**.** Only one school does not have gas boilers.

Note that some schools will only need Packages 1&3 to meet the net-zero target; some schools will need Packages 1,2&3; and a number of schools will require more substantial fabric measures under Packages 4 or 5 to meet the net-zero target.

Package 4 pragmatic retrofit is required only if a school cannot achieve the net-zero EUI target with Package 1,2,3 measures alone.

We believe most schools can achieve the EUI target of 75kWh/m^2.yr with a pragmatic Package 4 retrofit. This does not mean every building will achieve this EUI. For some hard-to-treat buildings such as listed buildings, achieving good energy efficiency is very difficult. However, poorer performing buildings can be balanced out with better performing buildings to achieve a whole school EUI<75kWh/m^2.yr.

Package 5 ambitious retrofit is appropriate for schools undergoing significant renewal or rebuilding. Measures such as external/internal wall insulation and replacing all windows with triple glazing are expensive and disruptive and most valid therefore in schools where a whole-school refurbishment is required for other reasons. Such refurbishment might be necessary due to significant building or structural defects or because of organisational change that requires significant building replanning.

Maintenance improvements should always be a trigger for thermal upgrades and if the repairs required affect a lot of walls and windows, this might justify a Package 5 retrofit. For example, for the 31 schools across the estate known to have walls and windows in poor condition.

In addition five schools in the study are undergoing significant change such as extension/refurbishment, demolition and rebuild, amalgamation with other school(s) and moving location. These schools would make good candidates for a Package 5 retrofit. For the purposes of this study, we propose Package 5 retrofits to two schools.

We urge the council to always consider retrofit in lieu of demolition. Recent research by RAFT for the DfE has shown that pragmatic retrofit ***always*** has lower whole life carbon emissions than demolition and rebuild - even if the new building is exemplary.

3.18 The whole estate solution - proposed works

WORKS PROPOSED		How many require the works? Schools	Buildings	What proportion of the total estate is affected?
PACKAGES	*Packages*			
1&3	Stand-alone measures + heating systems	19	35	
1,2&3	Stand-alone + simple fabric measures + heating systems	35	131	
4	Whole building pragmatic retrofit	16	59	
5	Whole building ambitious retrofit	2	6	
MEASURES & ENGAGEMENT	*Measures & Engagement*			
1	Energy management training	72	231	
	Energy monitoring	72	231	
	LEDs & PIRs throughout	48	159	45% of estate GIA
	All-electric kitchens throughout	assume 72	231	
	PV maximised	58	202	7% of estate roof area
	Point of use hot water throughout	assume 72	231	
	Draughtproofing of leaky doors & windows	72	231	
2	CWI to uninsulated cavities	18	40	11% of estate wall area
	Roof insulation to uninsulated roofs	42	not known	7% of estate roof area
	Triple glazing to single glazed windows/doors	29	48	30% of estate window area
3	ASHPs/GSHPs to replace all gas boilers	71	230	
4	As 1,2,3 + all roofs better insulated + airtightness + MVHR	16	59	
5	As 1,2,3,4 + all walls better insulated + all windows replaced	2	6	

The table opposite sets out how many schools require works under each package and under each measure.

19 schools can meet the net zero target with Packages 1&3 only. These schools are mostly (not always) dominated by post-2003 buildings and usually have an existing EUI that's lower than average. The schools are assumed to have insulated cavity walls and roofs, and no single glazing - but this needs validating on site.

35 schools need packages 1,2&3. This is the bulk of the school estate.

16 schools need pragmatic, whole-building retrofits to meet the net zero target. These schools all have above average existing EUI and are dominated by pre 1976 buildings.

As discussed on the preceding page, we propose that 2 schools consider undergoing ambitious Package 5 retrofit.

Our modelling suggests that simple stand-alone and fabric measures combined with ASHPs will be sufficient for the bulk of the school estate to meet the net zero target. However, our modelling is high-level and underpinned by assumptions. More detailed energy modelling informed by building surveys will be required to validate this proposal.

3.19 The whole estate solution - impacts

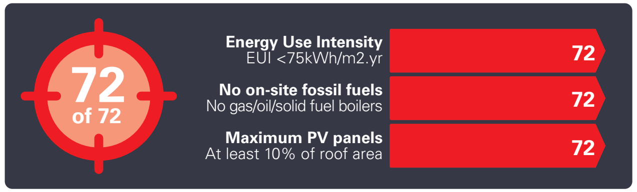
The energy, carbon and running costs impacts of this blended-combination are shown in the graphs on the right.

Energy consumption is more than halved and electricity generation from PV trebled.

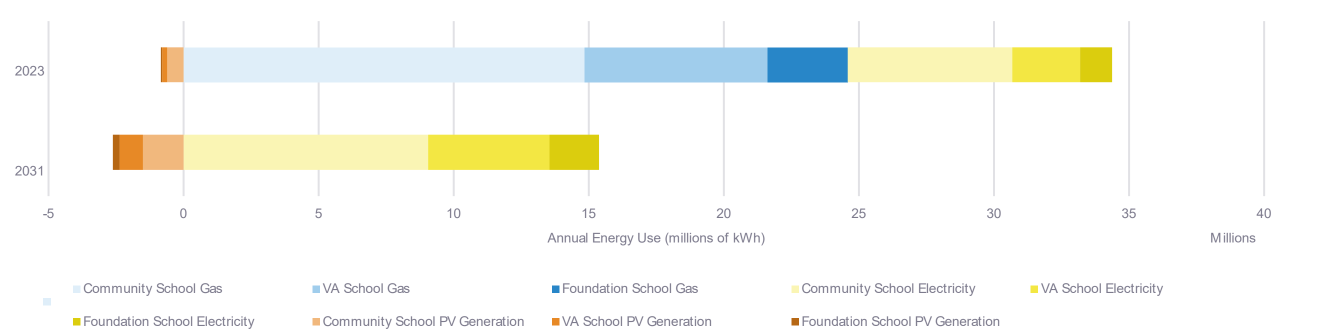
Carbon emissions are reduced by around 70%.

Annual energy bills are just under £1m lower.

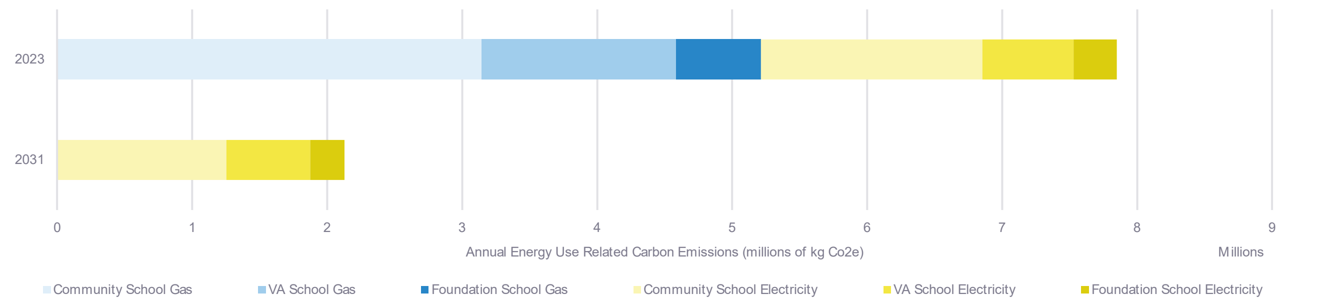
How many schools would be net-zero?



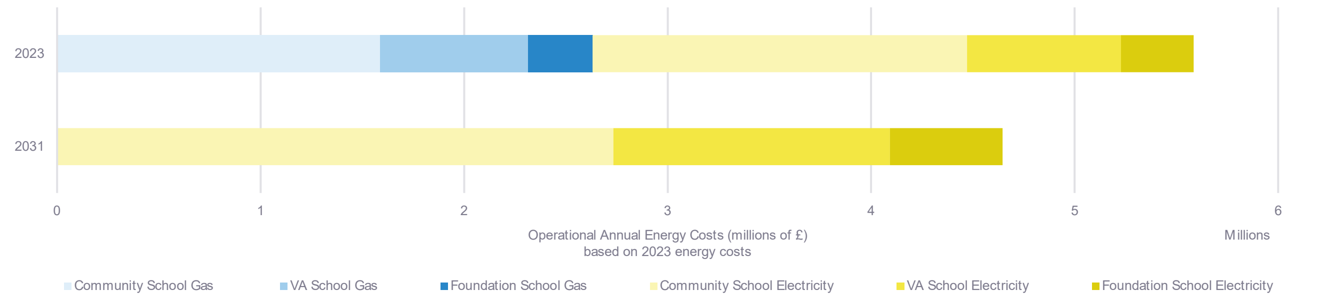
Annual estate energy use - Existing versus post-retrofit



Annual estate operational carbon emissions - existing versus post retrofit



Annual estate operational energy costs - existing versus post retrofit



4.0 Delivery

This section sets out the pathways for decarbonisation. It provides a plan for rolling out the measures required across the school estate and a tracker for measuring progress. The section also examines funding, procurement, resourcing and governance.

"In 2019, the UK government set out a target to achieve net zero greenhouse gas emissions across the whole UK by 2050.30 This commitment, enshrined in the Climate Change Act (2008), means that we have 30 years to completely decarbonise the economy."

HM Government, Heat & Buildings Strategy, 2021

RAFT
Retrofit Action for Tomorrow

4.01 Introduction

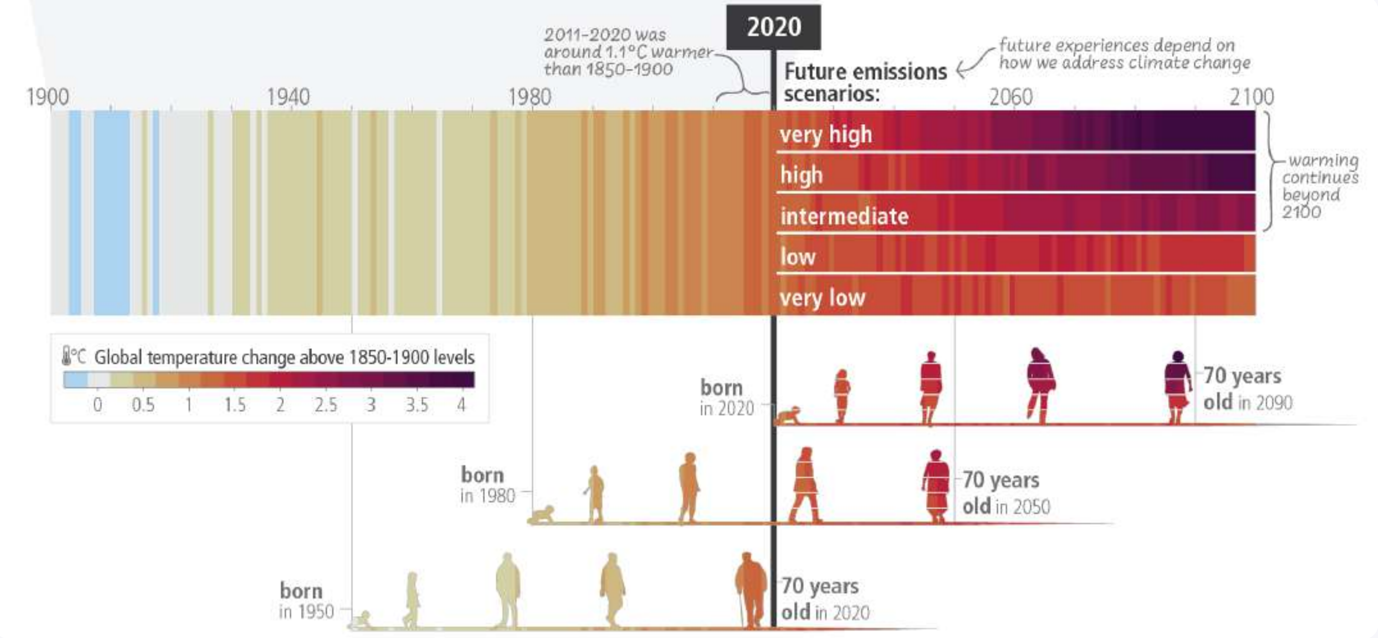
Under Section 3, we have identified a whole estate solution. We have determined which measures need to be applied to which schools to achieve the net zero target. This section examines how the works are best carried out.

Firstly, we define the **delivery aims**. Then we look at what **delivery approaches** or methods are required to meet these aims. Thirdly, we set out some **key principles for prioritising schools and programming the works**.

We then present an **estate delivery plan** which indicates how many schools and measures must be tackled each year up until 2030. This is supported by a **schools delivery plan**, which provides detail on every school. We also examine the year-on-year impacts of actioning this plan with regard to energy use, carbon emissions, energy costs and upfront capital costs.

The section then sets out the **capital costs** of this delivery plan and examines the **funding, procurement, resources and governance** procedures required to put it into action.

This section concludes with a **progress tracker** with which the council can chart its progress towards a decarbonised and net zero school estate.



4.02 Delivery aims

There are a number of priorities for delivering the required works to all of the school estate.

Local and national policy on carbon emissions inform two key aims. The first is to bring all schools to net zero by 2030 in keeping with Lambeth council's 2030 Zero Carbon commitment.

The second is to minimise carbon emissions on route, as part of a national effort to meet the UK's carbon budgets. One must not underestimate the importance of timing on overall emissions. The graph opposite shows how delaying the estate's decarbonisation works by just five years would increase overall operational emissions by almost 20,000 tCO_2e.

The proposed measures are extensive and to be able to achieve them one must minimise overall costs and disruption and maximise funding opportunities.

To implement these measures, one needs to improve knowledge and increase resources across the council, responsible bodies and schools.

And to maintain a long term positive impact, one needs to engage the wider community in the decarbonisation journey.

Policy aims

Align with carbon commitments

- Ensure all schools are zero carbon in operation by 2030 by carrying out all works by 2030
- Minimise overall CO_2e emissions by decarbonising fast
- Achieve year on year reductions in CO_2e emissions.

Maximise value

- Minimise whole life costs by always considering upfront costs, energy costs and maintenance costs (including emergency repairs)
- Minimise disruption from the retrofit works and from emergency repairs/damage by aligning decarbonisation and maintenance programmes
- Maximise funding opportunities by ensuring existing allocations are spent and blending funding from different pots and being 'funding ready'

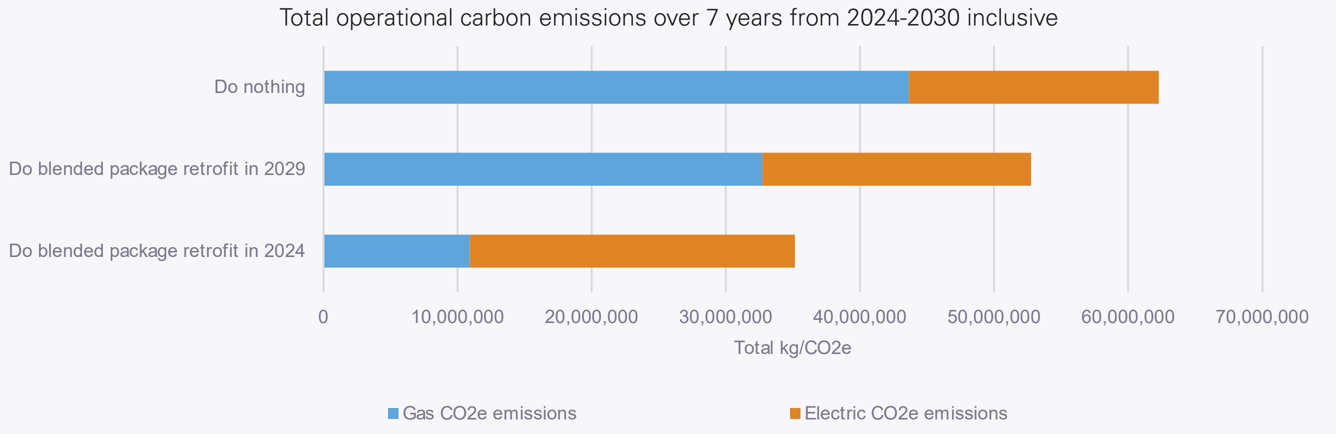
Implementation aims

Build capacity & knowledge

- Improve knowledge and resources at all levels of governance by utilising existing training programmes and guidance to disseminate knowledge
- Ensure lessons are learnt and impacts understood by monitoring energy usage and building performance and tracking progress across the whole estate
- Develop alternative funding streams

Optimise engagement & communications

- Win hearts & minds and accelerate climate action by engaging with the school community and sharing case studies
- Build ownership and pride by celebrating successes and extending change from within to encourage agency and leadership
- Ensure a just transition by demonstrating inclusion and signposting jobs and training



4.02 Delivery approaches

The core delivery aims noted above inform which approaches one should take towards programme and timings, procurement and funding options.

For example:

- determining which measures and schools to do in which order
- determining whether to undertake estate-wide programmes or carry out school-specific projects
- determining which costs to consider when deciding on measures
- determining the content of engagement programmes

		affects timings & programme	*affects procurement*	*affects costs & funding*	*involves engagement*
Align with carbon commitments	Complete all measures identified by 2030 - to meet 2030 zero carbon commitment	✓			
	Roll out simple measures (Packages 1&2) quickly using estate-wide programmes whilst rolling out more complex measures (Packages 3,4,5) using a school-by-school programme - to cut carbon fast whilst still progressing to net zero targets	✓	✓	✓	✓
	Assess 7yr carbon emissions when deciding on programme - to ensure overall emissions are minimised	✓			
Maximise value	Introduce measures to reduce energy consumption and loads prior to installing ASHPs - to reduce energy bills & minimise ASHP & electricity upgrade costs	✓	✓		✓
	Tackle end-of-life building elements and systems first - to minimise costs and disruption from emergency repairs	✓		✓	
	Maintain already scheduled work - to retain existing decarbonisation and maintenance programmes and funding. However, assess proposed measures to ensure energy efficiency upgrades have been optimised - to avoid doing work twice	✓	✓	✓	
	Roll out energy monitoring and management measures using existing engagement programmes - to maximise potential for energy and carbon reductions prior to carrying out physical retrofit measures		✓		✓
	Assess 7yr costs when deciding on which measures to undertake - to ensure overall costs are minimised, not just upfront costs	✓		✓	
	Track costs and funding opportunities - to build alternative funding and combined funding solutions, thus enabling multiple measures to be funded simultaneously		✓	✓	
Build capacity & knowledge	Build and leverage Council resources				
	Match the procurement route to the organisation in charge of the school		✓		
	Track progress centrally - to ensure progress to net zero target is fully understood and delivery plan can be adjusted if required		✓	✓	✓
	Monitor thermal performance, IAQ and energy consumption across all schools, introducing sub-meters where possible - to ensure impacts of different measures are known and to enable actions to further reduce consumption and improve comfort/health	✓		✓	✓
	Ensure all schools join energy management & monitoring training programmes - to disseminate knowledge about energy efficiency, share experience and report on progress			✓	✓
Optimise engagement	Deliver a range of programmes to win hearts, minds, understanding and action in different ways to different audiences (staff, pupils, premises managers) - to initiate, reinforce and build momentum.			✓	✓
	Set up channels to share case studies and good practice, and to celebrate successes				✓
	Develop awareness of jobs and careers within the green economy				✓

4.03 Delivery programmes & prioritisation

Given the aims and approaches discussed above we propose rolling out the works according to the programmes noted below and priorities noted opposite.

School-by-school works programme
Tackle around 10 schools/yr for Package 1,2,3 measures. Carry out package 4/5 retrofits to around 2-4 schools/yr - as these are harder to tackle and need more time to put plans in place.

Estate wide works programme
Deliver simpler measures to all schools over 2-3 years. This allows carbon to be cut even faster and is particularly beneficial to those schools that are retrofitted later on in the school-by-school programme.

Estate wide information programme
Most schools will require HDPs prior to ASHP installation. For schools requiring no fabric measures, an ASHP feasibility study should suffice. Where simple measures are to be rolled out before HDPs have been done, surveys/feasibility studies are required. All schools also require live metering and IAQ monitors.

Estate wide engagement programme
Deliver energy management and monitoring training to all schools over 2-3 years. Continue knowledge sharing and reporting up to 2030.

School-by-school works programme - all measures

Roll out the schools in the following order of priority:

1. Schools with **scheduled ASHP replacements** (to ensure heat and electricity demand and load are reduced as much as possible before ASHP replacement)
2. Schools with **end-of-life boilers** (to get these schools 'ASHP ready' before the gas boiler fails, avoiding replacement with a new gas boilers)
3. Schools with **high carbon emissions** (to cut carbon fast from big emitters)
4. Schools with **high EUI** (to cut carbon fast from expected low-hanging fruit)
5. Schools with **scheduled maintenance works** (to ensure maintenance works involve energy efficiency upgrades where possible)
6. Schools with **poor building fabric** (to align future maintenance works with energy efficiency upgrades)

Estate wide works programme - simpler measures

Roll out according to the measure-specific priorities noted below, bearing in mind that simple measures **must** be done prior to the installation of ASHPs:

- **LEDs & PIRs**: schools with non-LED lights in poor condition (to avoid emergency replacement with non-LEDs), schools with the least LEDs (to maximise impact)
- **All electric kitchens:** schools with kitchen appliances in poor condition (to avoid emergency replacement with new gas appliances), schools with big kitchens (to maximise impact)
- **PV maximised:** schools where roofs are in good condition & well insulated (to allow fast roll-out)
- **POU hot water**: schools with end-of-life hot water cylinders/systems (to avoid emergency replacement with new central storage systems)
- **Draughtproofing of leaky doors/windows**: schools with highest number of leaky windows (to maximise impact)
- **CWI to uninsulated cavities + insulation to uninsulated roofs**: buildings where insulation presents a low moisture risk (to allow fast roll-out)
- **Triple glazing to single glazed windows/doors**: buildings with the most single glazing (to maximise impact), buildings that aren't listed or in conservation areas (to allow fast roll-out)

Information programme

Carry out HDPs & ASHP feasibility studies 1-2 years prior to retrofit under school-by-school programme

- HDPs: all schools needing ASHPs + fabric measures
- ASHP feasibility studies: schools needing ASHPs but no fabric measures

Carry out single measure feasibility studies 1 year prior to installation under estate wide programme

- Electrical capacity surveys
- LED feasibility studies
- Kitchen appliances surveys
- PV feasibility studies
- POU feasibility studies
- Door/window leakiness & single glazing survyes
- Uninsulated roofs & wall cavities - surveys + risk assessments

Install live meters & monitors in all schools

- energy meters & submeters
- temperature & IAQ monitors

Engagement programme

Roll out the schools in this order:

1. Schools already on engagement programmes
2. Schools tackled early in the school-by-school programme

4.04 Estate delivery plan

SCHOOL-BY-SCHOOL PROGRAMME

		How many schools/buildings require the works?	
All packages		schools	buildings
1&3	Stand-alone measures + heating systems	19	35
1,2&3	Stand-alone + simple fabric measures + heating systems	35	131
4	Whole building pragmatic retrofit	16	59
5	Whole building ambitious retrofit	2	6
All measures except engagement			
1	LEDs & PIRs throughout	48	159
	All-electric kitchens throughout	assume 72	231
	PV maximised	58	202
	Point of use hot water throughout	assume 72	231
	Draughtproofing of leaky doors & windows	72	231
2	CWI to uninsulated cavities	18	40
	Roof insulation to uninsulated roofs	42	not known
	Triple glazing to single glazed windows/doors	29	48
3	ASHPs/GSHPs to replace all gas boilers	71	230
4	As 1,2,3 + all roofs better insulated + airtightness + MVHR	16	59
5	As 1,2,3,4 + all walls better insulated + all windows replaced	2	6

ESTATE WIDE PROGRAMME

		How many schools/buildings require the works?	
Simple measures only		schools	buildings
1	LEDs & PIRs throughout	48	159
	All-electric kitchens throughout	assume 72	231
	PV maximised	58	202
	Point of use hot water throughout	assume 72	231
	Draughtproofing of leaky doors & windows	72	231
2	CWI to uninsulated cavities	18	40
	Roof insulation to uninsulated roofs	42	not known
	Triple glazing to single glazed windows/doors	29	48

The tables on this and the following page - the **Estate delivery plan** - summarise the number of schools and buildings affected under each of the four programmes:

- school-by-school programme (packages of measures)
- estate wide programme (individual measures)
- engagement programme
- information programme

The roll out of these programmes over time is not indicated as this depends entirely on the funding that can be found.

Also the Council are anticipated to influence, support and co-ordinate with VA and Foundation schools' responsible bodies. RAFT is in a unique position of carrying out high level HDPs for both Lambeth council and the Southwark Diocesan Board of Education (SDBE), who have voluntary aided schools in Lambeth. Schools may be prioritised differently by the two organisations, resulting in different roll-out timeframes for some schools. This needs to be coordinated and managed carefully to avoid mixed messaging to schools.

The Engagement and Information programmes need to be set up to deliver the necessary engagement and information in a timely manner for the works programmes.

4.04 Estate delivery plan

INFORMATION PROGRAMME

	How many schools/buildings require the info?	
Information required for all programmes	schools	buildings
Condition of building fabric (this information has already been gathered)	0	
Condition of building services (this information has already been gathered)	0	
Information required for School-by-school programme		
Existing school PSDS applications - review net-zero-compatibility (all schools with PSDS funding)	15	
Existing school maintenance plans - review net-zero-compatibility (all schools with scheduled maintenance works)	19	
School HDPs (all schools requiring ASHPs + fabric measures)	45	
School ASHP feasibility studies (all schools requiring ASHPs only)	17	
Information required for Estate-wide programme		
Peak electrical load & capacity (all schools that have non-CT meters)	56	
LED & PIR coverage - surveys + feasibility studies	48	
Kitchen electrification coverage - surveys + feasibility studies	assume 72	
PV coverage & capacity - surveys + feasibility studies	58	
POU coverage - surveys + feasbility studies	assume 72	
Extent of leaky windows/doors - surveys + risk assessment	72	
Extent of uninsulated cavity walls - surveys + risk assessments	18	
Extent of uninsulated roofs - surveys + risk assessments	42	
Extent of single glazing - surveys + risks assessments	29	

NOTE: all the information gathered under estate-wide surveys for the estate-wide programm

ENGAGEMENT PROGRAMME

	How many need to be involved?	
Engagement & monitoring measures only	schools	buildings
Energy management training	72	n/a
Energy monitoring & reporting	72	n/a

4.05 Delivery plan costs

If the measures are carried out according to the time line on the preceding pages, **the total project cost is approximately £235 million**, of which just over half is construction costs. See table opposite. The cost allocations for risk are high due to the uncertainty given the high-level nature of this plan. Contractor costs include staff, site accommodation and site power. Development costs include consultant design fees.

Of the construction elements, ASHPs are the most costly - £32.4 million (14%) - and this cost would increase to over £38m if ASHPs were installed without fabric measures. Fabric improvements to reduce heat loads lowers the cost of ASHPs by avoiding oversized units. Load reduction also reduces the risk of additional electrical infrastructure upgrades (whose costs have not been accounted for in these estimates).

63% of the costs are associated with schools receiving Package 1,2,3 measures. 35% are attributed to the 16 schools receiving Package 4 retrofits. 4% of the costs are for the two Package 5 schools.

Community schools make up 59% of estimated costs (and 57% of schools), Voluntary Aided schools 30% (and 32% of schools) and Foundation schools 8% (and 11% of schools).

Breakdown of wall insulation by type/ package	
CWI only (packages 2&4)	£13.1m
CWI + EWI (package 5)	£0.6m
curtain walling (package 5)	£0.8m
Breakdown of roof insulation by type	
Pitched roofs in good condition	£3.7m
Pitched roofs in poor condition	£4.1m
Flat roofs in good condtion	£2.9m
Flat roofs in poor condition	£2m
Roofs assumed to be uninsulated	£0.2m

Estate Delivery Plan TOTAL	**£235,100,000**
LED	£17,700,000
PV	£2,600,000
POU	£10,100,000
Electric Kitchen	£8,700,000
Wall Insulation	£13,800,000
Roof Insulation	£13,000,000
Glazing	£11,900,000
ASHP	£32,500,000
Radiators & Pipework	£12,700,000
BMS	£7,300,000
MVHR	£7,800,000
Estate Delivery Plan Construction	**£129,900,000**
Development Costs	£19,500,00
Risk Allowances	£52,000,000
Contractor Costs	£26,000,000

Total construction costs

4.06 Funding

Existing funding will not be sufficient to achieve Lambeth's 2030 goals. The current funding shortfall is around £43m for maintenance works alone and a further £230m for decarbonisation works - see table opposite.

Funding can come from numerous sources but the primary funding streams used by Lambeth for their schools are the School Capital Maintenance programme (SCM) and the Public Sector Decarbonisation Scheme (PSDS).

It is clear that funding from alternative sources will be required. Alongside further PSDS applications, a combination of approaches will need to be pursued. The table opposite illustrates a range of funding and finance.

A structured funding development programme is needed and this should maximise:

- portfolio-level and school-level funding
- measure-led and whole-building-retrofit funding
- funding/borrowing for more "bankable" short payback measures, releasing SCA funds for other measures
- future GLA and government funding streams
- community energy funding
- new energy efficiency and decarbonisation funding, whenever launched

	Anticipated costs	Funding in place	Funding shortfall
Maintenance Works	£58m (Lambeth condition survey)	£13m from 2023-27 (SCM) £2.5m from alternative reserves identified by MPPG Capital Studio	£42.5m
Decarbonisation Works	£235m (RAFT HDP)	£2.3m (PSDS3b) £3.5m (Lambeth council funding)	£230m

Funding	Name	Community	VA	Source	Description - type of funding / scope
National School Funding					
SCA	School Condition Allocation	Y	Y (VA-SCA)	DfE	Central government funding for capital works. Prioritised on keeping school buildings safe and in good working order by tackling poor building condition, building compliance, energy efficiency, and health and safety issues
DFC	Devolved Formula Capital	Y	Y	DfE	Central government funding for individual schools, for building maintainance and small capital projects.
DSG	Dedicated Schools Grant	Y	Y	DfE	Central government funding for school operational costs, including energy bills.
National Decarbonisation Funding					
PSDS	Public Sector Decarbonisation Scheme	Y	Y	DESNZ (previously BEIS)	Grants for public sector organisations to decarbonise heat in their buildings in line with the government's goal of reducing emissions from public sector buildings by 75% by 2037 (based on 2017 baseline)
LCSF	Low Carbon Skills Fund	Y	Y	DESNZ (previously BEIS)	Grants for public sector organisations to engage the specialist and expert advice and skills required to put in place a heat decarbonisation plan.
Alternative sources of funding					
s106 funding	-	Y	Y	LA, from developers	Funds available to local authorities, often used to set up LA-run community energy funds, and to support unfunded projects
Portfolio or place-based green bonds/debentures/debt facilities	eg Municipal bonds, MEEF financing etc	Y	Facility-dependent	Capital Markets, Debt crowdfunding	Debt facility raised on a portfolio basis, including for specific measures, particularly those with shorter payback periods
Mayor's Green Finance London Programme	Finance streams tbd, supported by Mayor's Green Bond	Y	Facility-dependent	GLA, private sector investment	Future debt finance programme for "bankable" projects.
MEEF (stopping 2024)	Mayor of London's Energy Efficiency Fund	Y	Y	GLA	Senior debt, mezzanine debt or equity for viable low carbon projects. Only higher and further education & only London.
Community energy funds eg LCEF	London Community Energy Fund	Y	Y	GLA	Grant funding supporting community energy projects. LCEF6 2023 streams: feasibility (£15k), pre-feasibility (£5k), and capital works (33% funding, or 20% for PV & LED, capped at £50k)
Community fundraising eg crowdfunding platforms, community energy groups, direct fundraising, match funding initiatives	Various	Y	Y	Local community, general public	Fundraising via donation, share or loan investment

4.07 Procurement

Getting all 72 schools to net-zero requires a suite of different measures that vary enormously in type, cost, responsibility, funding options and programme approach.

Some measures are about people and knowledge sharing, some are behavioural, some are simple maintenance and some demand large scale building works. Some measures must be enacted by the school, some by responsible bodies (if applicable) and some by the council. Some measures might be installed by a school on its own. Others could be installed under estate-wide programmes. Funding will come from many different sources.

Consequently a host of different procurement routes will be required. We advise the council to develop a 'funding & procurement' tracker, which identifies for every school and every measure the costs and funding situation as well as which organisation is responsible for delivery.

The tracker would enable all organisations to be "funding-ready", so that they can act rapidly to optimise all future funding opportunities as well as combine funding from different pots.

See sample tracker below.

On contracting approaches, the Council should consider incorporating performance metrics and linked penalties/rewards into standard contracts. Performance based contracts can support delivery and mitigate quality and performance gap risks. They are also useful where finance arrangements demand impact-based metrics.

The Council and schools should also adopt minimum standards in maintenance and capital works to ensure they are compatible with the net-zero aims. The Council could update its Schools Maintenance Handbook with standards.

sample FUNDING & PROCUREMENT TRACKER

School	Measures Required	School-by-school works programme	Estate-wide works programme	Information programme	Engagement programme	Estimated cost (£)	Approved funding (£)	Approved funding source	Future funding options	Lead organisation	Procurement route
Example School	School HDP							LCSF		Lambeth / school	
	PV feasibility study							LCSF		Lambeth	
	Energy Management & Behaviour								LCSF	Lambeth	
	PV								LCEF	Lambeth	
	LEDs							DFC			
	POU								PSDS		
	Kitchen upgrade										
	CWI								PSDS		
	Triple glazing to replace single glazing							SCA	PSDS		
	ASHP								PSDS	School	

4.08 Delivery risks & challenges

A number of programme, financial and quality risks affect this high-level HDP and its successful implementation - ie. getting all 72 schools to net-zero by 2030. The table on this and the following pages identifies these risks alongside ways to mitigate them.

Key actions are highlighted in bold, many of which are picked up under *Section 5: Next steps*. These are also summarised as six key areas in the box on the right.

1. Build knowledge about the existing estate
2. Share knowledge through engagement & guidance
3. Coordinate maintenance and decarbonisation programmes, standards, guidance & procurement
4. Develop partnerships across the council, responsible bodies, schools, consultants & contractors
5. Plan in advance
6. Monitor the works and their impacts

Issue	Risk	Mitigation & management
Responsibilities	A complex web of different people and organisations are responsible for the management of school buildings and systems. This can result in confusion as to who is responsible for what, particularly given that the retrofit measures proposed differ greatly in cost and type - from engagement programmes to minor maintenance to major capital works.	The Council have provided a detailed table of maintenance and capital works responsibilities in their **Schools Maintenance Handbook** (2022). This could be extended to include energy efficiency works. Joined up planning and implementation between schools, governing bodies, responsible bodies and the council is essential. An **ongoing knowledge-sharing programme** would facilitate these partnerships.
Funding	Due to the varied nature of the measures required, funding will have to come from multiple sources. Some funding programmes are available direct to schools, others to councils, and others to responsible bodies (eg DIocese). All have different rules and requirements. There is also uncertainty year-to-year about the level and type of funding available.	The Council have carried out a thorough **evaluation of their school estate's maintenance** needs, identified an enormous funding gap and created a plan for maintenance works with the limited funds available. Extending this exercise **to include net-zero goals** is critical - so that maintenance upgrades and energy efficiency measures can go hand in hand. We propose that the Council **develop a 'Funding & procurement' tracker** that combines maintenance needs and energy efficiency measures and assesses the funding options available.
Resources	This is an ambitious programme, which will stretch already limited resources at school, responsible body and council level. All of these organisations are unlikely to have all of the technical expertise to plan and implement such a programme. The UK supply chain for building retrofit is in its infancy. There is a lack of knowledgeable designers and contractors and a lot of poor practice in the retrofit industry. Particularly problematic is the widespread installation of fabric measures as stand-alone elements with often disastrous consequences. Also, competent ASHP designers, installers and maintainers are in short supply.	The Council and RAFT have already introduced **workshops to train premises managers** about energy efficiency and management. This should be rolled out to all the schools and governing/responsible bodies. The Council have appointed consultants to manage their School Capital Maintenance programme over a 3 year period. We recommend having **specialist consultants manage the estate's Decarbonisation programme**, ideally integrating the two. The Council frequently **use frameworks of consultants and contractors** to procure maintenance works. This approach provides supply chains certainty about future works and the ability to invest in the necessary upskilling. A similar approach to decarbonisation works would be beneficial - providing there is scope to remove sub-standard actors from the frameworks.

4.08 Delivery risks & challenges

<table>
<tr><td>Knowledge</td><td>This HDP is based on desktop analysis of numerous sources, including detailed condition surveys carried out by the Council. However, no on site investigations were made. Consequently many assumptions have been made about building fabric and services, which need to be validated.</td><td>The Council have good knowledge about building condition and fire safety issues. This needs to be extended to energy efficiency issues through a comprehensive knowledge-building programme. This can be done through individual school HDPs or through estate wide surveys.</td></tr>
<tr><td>Programme</td><td>There are a host of obstacles that are likely to slow down the roll-out of this decarbonisation plan. These include:
obtaining planning and listed building consents
obtaining electrical infrastructure (DNO) upgrades
working in live schools and needing to programme disruptive works for the school holidays only
carrying out Asbestos surveys and removal
finding the unexpected, which is a frequent occurrence in schools that have been added to and refurbished in a piecemeal manner over many years</td><td>The approach needs to be one of ‘get the ball rolling’ on measures that require a long time due to approvals/upgrades/surveys required, whilst acting fast on the easier-to-implement measures.
identify any schools where the measures will require planning, conservation area or listed building consents and begin the applications process at least a year in advance of planned implementation.
survey all schools electrical capacity and loads ASAP. Identify those where upgrades will likely be required and begin the process with the DNO.
create a repeatable annual programme that identifies which measures can be carried out during term time versus those that must be done during the holidays
consider sharing vacant premises or temporary facilities between schools on rolling programme.
assess each school’s asbestos knowledge and carry out early asbestos surveys</td></tr>
<tr><td>Costs</td><td>The costs identified in this report are approximate, based on high-level modelling of the entire school estate. There is also significant inflation across the construction industry at the moment. Costs therefore need to be verified.

Decarbonisation measures can have an enormous impact on utility bills with ASHPs pushing costs up and energy efficiency measures and PV generation pushing running costs down. These impacts need to be verified.</td><td>Carry out estate wide surveys and individual school HDPs to firm up cost estimates.

Ensure whole-life costs (including future energy bills) are taken into account when deciding on measures, not just up-front costs</td></tr>
<tr><td>Missed opportunities</td><td>When emergency repairs or replacements take place, these are often carried out with little regard for energy efficiency upgrades. These are missed opportunities and may lock in carbon-intensive systems (eg. a new boiler) for a long time.</td><td>Decarbonisation aims and measures should be more deeply embedded throughout the Council’s frameworks and guidance. The Council should have net-zero maintenance specifications/standards, to ensure maintenance repairs or replacements support the net-zero targets, which are referenced in the Lambeth School Building Maintenance & Compliance Handbook.

Schools with end-of-life boilers and hot water cylinders should have heating and hot water systems resilience plans. These plans examine temporary heating/hot water options, that could serve the school in the event of system breakdown until an ASHP can be installed.</td></tr>
<tr><td>Performance gap</td><td>The ‘performance gap’ in the construction industry is endemic - whereby works carried out fail to achieve the expected standards or impacts. This can be due to failures in design, construction or commissioning. Frequently, the performance gap isn’t even noticed due to a lack of quality assurance or post occupancy evaluation .</td><td>Ensure contracts have clearly defined QA processes. Provide additional resources or training to arm the Council and schools with the technical skills to ensure contracts are administered properly. Use performance based contracts.

Carry out post occupancy monitoring, particularly in the first year, to ensure systems have been commissioned properly and verify impacts against contract requirements.</td></tr>
</table>

4.09 Progress Tracker

		No. of schools where condition applies	Current status	Status at end of... 2023	2024	2025	2026	2027	2028	2029	2030
INFO	**Knowledge**										
	most schools to have an HDP	45	10								
	some schools to have an ASHP feasibility study	17	2								
	some schools to have LED/POU/PV feasibility studies, where required prior to HDPs being available	tbc following programming decisions	2								
	all schools with an end-of-life boiler to have a Heating Resilience Plan	11	0								
	all schools to know their electrical capacity and peak loads	72	16								
MEASURES	**Energy efficient**										
	all schools to achieve an EUI<75kWh/m2.yr	72	1								
	all schools to do energy management training	72	21								
	all schools to do continuous energy monitoring	72	not known								
	all schools to have 100% LED coverage	72	24								
	all schools to have 100% POU hot water	72	not known								
	all schools to have all-electric kitchens	72	not known								
	all schools to have good draughtproofing	72	not known								
	all schools to have zero uninsulated cavity walls	72	54								
	all schools to have zero uninsulated roofs	72	30								
	all schools to have zero single glazing	72	43								
	some schools to have pragmatic whole-building retrofits	16	0								
	some schools to have ambitious whole-building retrofits	2	0								
	No fossil fuels on site										
	all schools to have gas supply removed	72	not known								
	all schools to have no gas boilers	72	1								
	On-site renewable energy										
	all schools to install the maximum possible PV on roofs - nominal 10% of roof area	72	14								
IMPACTS	**All schools to be net zero**		**0**								
	Total annual CO2e emissions (tCO2e/yr)	n/a	8,500								
	Total annual gas consumption (kWh/yr)	n/a	25,740,000								
	Total annual electricity consumption (kWh/yr)	n/a	10,516,000								
	Total annual energy costs (£/yr) - excludes income from or energy savings due to PV	n/a	5,930,000								
	No. of schools with good comfort levels (annual survey)	72	not known								
	Total annual PV generation (kWh/yr)	n/a	880,400								
	Total PV capacity (kWp)	n/a	930								
	Median EUI (kWh/m2.yr)	n/a	151								
	Top decile EUI (kWh/m2.yr)	n/a	98								
	Bottom decile EUI (kWh/m2.yr)	n/a	229								

Key to a successful implementation of this HDP is tracking the estate's progress towards the 2030 goal of all 72 schools being net-zero. It is essential to understand whether the programme is being adhered to and whether the expected impacts are being achieved. If not, the proposed measures and programme will need adjusting to ensure the 2030 net-zero target is still met.

The chart opposite does this. The RAFT database can be continuously updated in three ways:

- to reflect new information about schools and ensure the scope of measures are correct.
- to measure progress in terms of packages/ measures carried out
- to measure progress in terms of impacts on carbon, energy, energy costs, electricity generation and comfort.

It is useful to assess whether thermal comfort and indoor air quality improve - to determine whether the retrofit measures are having a beneficial impact on the building occupants. This can be done through ongoing temperature, CO_2 and relative humidity monitoring of classrooms, offices and halls.

5.0 Next steps

This section sets out the steps that must be taken in 2023 by the council, responsible bodies and schools.

Children taking part in an educational retrofit workshop

"The actions we take to respond to climate change can contribute to broader goals we have for our borough, such as improving health and wellbeing, increasing prosperity and opportunity, and reducing inequality."

Lambeth Council Climate Action Plan, 2022

RAFT Retrofit Action for Tomorrow

5.01 Next steps - core actions

This HDP shows how 72 schools across Lambeth can be decarbonised to meet the net-zero target.

The work required will be need to be implemented by a mix of council departments and organisations including: the schools, the schools' responsible bodies, the council's sustainability and climate change team, the council's facilities management (FM) team and the council's MPPG/Capital Studio team.

A coordinated approach is required to implement the four key programmes:

- school-by-school works programme
- estate-wide works programme
- information & monitoring programme
- engagement programme

It is important that organisations involved sign up to the core aim of getting all schools to net-zero by 2030.

It will also be important for the Council to review its policies and procedures to ensure coordinated decision making and planning can happen - particularly in respect to combining maintenance and decarbonisation programmes.

These core actions are summarised in the box opposite. In addition, it's worth remembering the six key areas for mitigating risk, noted in Section 4 above - see box below right.

The following pages set out the actions required at Council level and School level to implement the four programmes.

Formal declaration

- [ ] The Council, Responsible bodies & Schools sign up to and formally declare the core aim of all schools being net-zero by 2030
- [ ] The Council, Responsible bodies & Schools all recognise decarbonisation as an urgent need and embed the net-zero aim in all frameworks and guidance

Council organisation

- [ ] Create an inter-departmental task-force to coordinate the four programmes alongside maintenance works
- [ ] Amend policies to ensure all maintenance, minor and major works to schools require sign off by the Sustainability and Climate Change Team
- [ ] Agree annual reporting procedures for tracking the schools' decarbonisation progress

- Build knowledge about the existing estate
- Share knowledge through engagement & guidance
- Coordinate maintenance and decarbonisation programmes, standards, guidance & procurement
- Develop partnerships across the council, responsible bodies, schools, consultants & contractors
- Plan in advance
- Monitor the works and their impacts

5.02 Next steps - council actions

The Council's actions can loosely be categorised into four groups.

- leadership & decision making
- information & monitoring
- coordinated guidance
- coordinated planning

In addition, engagement actions are included in Section 5.04 below.

Heating & hot water system resilience plans
These plans identify schools at risk of boiler or hot water cylinder failure and provide contingency measures to ensure new gas boilers and central hot water storage not installed if existing boilers/cylinders fail. This requires:

- audit of estate boiler & hot water cylinders to identify at risk schools (this has been done)
- audit of electrical capacity to identify schools requiring electrical upgrades
- system design for ASHP installation and POU hot water installation including heat load reduction measures and electrical upgrades
- temporary solution design for situations where a failed boiler/cylinder cannot immediately be replaced by an ASHP/POU hot water. For example: leasing a boiler, portable electric heaters.

Leadership & decision making

- [ ] Review delivery plan & confirm first two tranches of schools in the school-by-school programme
- [ ] Decide which measures (if any) can be rolled out under estate-wide works programmes
- [ ] Decide on which decarbonisation funds to apply for in 2023

Information & monitoring

- [ ] 1st tranche of schools - review existing PSDS applications to ensure existing HDPs/ASHP studies are sufficient and proposed works are compatible with net-zero targets
- [ ] 2nd tranche of schools and potentially 1st tranche also – apply for LCSF funding for school HDPs
- [ ] Carry out estate-wide surveys/feasibility studies as required to support estate-wide works programme
- [ ] Carry out estate-wide analysis of school electrical infrastructure and capacity
- [ ] Verify boiler age/condition across all schools.
- [ ] Ensure RAFT database is continuously updated to reflect new information - apply for LCSF funding for this
- [ ] Install sub-meters and IAQ/thermal monitors in community schools and encourage installation in VA and Foundation schools - starting with the 1st tranche of schools + schools on engagement programmes
- [ ] Ensure Progress Tracker is continuously updated to reflect year-on-year decarbonisation progress

Coordinated guidance

- [ ] Write Employers Requirements for maintenance and energy efficiency measures compatible with the net-zero target
- [ ] Works with schools at risk of boiler/hot water cylinder failure to produce school-specific heating and hot water system resilience plans
- [ ] Update Lambeth School Building Maintenance & Compliance Handbook with reference to decarbonisation and net-zero requirements/standards

Coordinated planning

- [ ] Review School Capital Maintenance programme to ensure scheduled works are compatible with net-zero targets
- [ ] Update decarbonisation delivery plan and estimated costs (following input of new information)
- [ ] Produce combined maintenance and decarbonisation Funding&Procurement tracker

5.03 Next steps - school actions

It is important for schools to be directly involved in decarbonisation action, including:

...to sign up to the aim of being net-zero by 2030 and take the other actions identified here.

...to ensure that their buildings are ‘retrofit ready’ - ie. in good repair. These are things that don’t necessarily require funding but need to be done by the school to ensure the building fabric can dry out. These are simple maintenance measures that are often overlooked due to time pressures, but are vitally important.

...if a school is earmarked for 2024/25, to start preparing now, to ensure long-lead-in items like asbestos, planning and electrical infrastructure upgrades do not delay the works.

...to sign up to council engagement programmes - this is discussed on the following page.

The boxes opposite summarise the immediate next steps for each school. Yellow boxes indicate actions which are the responsibility of the school. Empty boxes indicate actions which should be carried out in coordination with the Council / responsible body.

Empower your school to act

- ■ Make formal declaration of net-zero aim
- ■ Appoint a Green Governor with responsibility for oversight of climate action and for delivering the heat decarbonisation.
- ■ Be clear about the exact nature of the relationship between the school, local authority, responsible body (if applicable) and School Governors, and the process for signing off decisions.
- ■ Establish the ownership of the school buildings and the land they stand on.
- ■ Get to know and explore your potential funding opportunities. Look for other local funds available from the Mayor’s office, charities and churches as well as other commercial organisations like the utility suppliers.
- ■ Get your school on board with the idea. Understand your stakeholders and get their support. Communication is important to get the broad range of stakeholders ready to accommodate and feel positive about the change. This helps generate momentum.
- ■ Switch your energy to a green energy supplier/tariff
- ■ Establish resource for annual reporting on decarbonisation progress

Get buildings retrofit ready

- ■ Verify all boilers’ age and condition and prepare heating and hot water system resilience plans
- ■ Clear out gutters
- ■ Repair failed rainwater goods
- ■ Deal with any damp areas to give fabric an opportunity to dry out before measures are undertaken.
- ■ Resolve any leaks (check above stained patches on suspended ceilings)
- ■ Make a list of any other ‘retrofit ready’ recommendations that do not require significant resources
- ■ Ensure floor vents are free from obstructions (move debris and leaves)

Prepare for implementation (most relevant to schools being retrofitted in 2024 and 2025)

- ■ Check asbestos issues and carry out a targeted asbestos survey if required
- ■ Apply for statutory consents if required
- ■ Check electrical infrastructure and capacity. Apply for upgrades if required.
- ☐ Review scheduled PSDS and SCM works. Are they net zero compatible? If not, establish what upgrades and additional works are required.
- ☐ Apply for Low Carbon Skills Funding to carry out HDPs
- ☐ Then...apply for PSDS funding to carry out the works

5.04 Next steps - engagement & monitoring

The council can utilise and build on its existing engagement programmes in a number of ways:

- train schools about energy management and simple energy saving measures
- share knowledge about funding opportunities
- train schools about energy and thermal/IAQ monitoring
- share experience and report on progress

General engagement

Council actions

- [ ] Continue **Future Fit Schools Network** Knowledge-sharing (See Section 2.12 for details)
- [ ] Continue **School workshop programme** - (See Section 2.12 for details)
- [ ] Continue **Premises manager training** (See Section 2.12 for details)
- [ ] Implement **post-HDP moment building programme** - to assist school leadership teams of schools with HDPs in implementing their retrofit measures
- [ ] Collate guidance and case studies into a **net-zero knowledge hub**

School actions

- [ ] Know the measures your school needs and when your school is expected to be retrofitted under the school-by-school works programme
- [ ] Sign up to and attend council engagement programmes
- [ ] Share information on plans, action and progress within the school and with the wider school community
- [ ] Involve staff and pupils in preparation and action wherever possible, promoting agency and leadership
- [ ] Use opportunities to share and discuss important messages such as climate justice, climate resilience and vital green skills, jobs and careers
- [ ] Communicate climate action via the school's wider networks. For example, the Future Fit Schools Network and social media

Monitoring

Council actions

- [ ] Implement **estate-wide monitoring training** - to show schools how to install, maintain and track energy meters and thermal/IAQ monitors
- [ ] Implement **energy management diagnosis & support programme** - for schools who have real-time energy monitoring, to build that data into immediate energy efficiency actions
- [ ] Provide metering & monitoring guidance for schools
- [ ] Implement centralised database/website where live energy and comfort/IAQ data from schools can be collated.
- [ ] Provide forum for school reporting and feedback on energy, thermal comfort and IAQ monitoring

School actions

- [ ] Assess electrical metering - can submetering be easily installed so that energy consumption each individual building and the kitchen plus is known.
- [ ] Install live energy displays in the main entrance of every building
- [ ] Install RH, temperature and CO2 monitors in classrooms, offices and main halls
- [ ] Ensure meters and monitors are linked to LBL's central database
- [ ] Track energy use and report on progress to the council & other schools through the engagement programme

6.0 Appendices

The appendices include detailed information about data sources, modelling assumptions, the building archetypes and costs. References are also provided.

Children taking part in an educational retrofit workshop

"Climate adaptation and decarbonisation activity in nurseries, schools, colleges, universities and care buildings can provide powerful learning opportunities."

Department for Education, Sustainability & and climate change: a strategy for the education and children's services systems, 2022

RAFT
Retrofit Action for Tomorrow

6.01 Salix QA mapping to RAFT HDP

			Section in HDP
1. Executive Summary			
A	Summary description of heat decarbonisation measures to be undertaken	☑	Page 5
	Proposed technologies / systems to be implemented, costs & carbon savings	☑	Page 5
2. Introduction, policy, and context			
B	Introduction	☑	Section 1
C	Portfolio	☑	Section 2
C	Buildings	☑	Section 2
C	Existing building characteristics	☑	Section 2
3. Current energy and heating technologies			
D	Energy consumption and carbon emissions	☑	Section 2
E	Heating and hot water systems	☑	Section 2
4. Determining the whole solution			
F	Whole building solution explained in the plan	☑	Section 3
G	Previous energy efficiency projects and existing low carbon heating technology	☑	Section 2
H	Heating networks and opportunities on site	☑	Section 2
I	Electricity loading capacity to support a switch to electric heating solutions	☑	Section 2&3
5. Estimating costs and budgets			
J	Have the costs from all different parts of the process been captured?	☑	Section 4
6. Delivery plan			
K	How will you deliver the work?	☑	Section 4
7. Resources			
L	Have available resources been considered?	☑	Section 4
L	Resources for this project explained	☑	Section 4
8. Supporting information			
M	Is supporting information included as outlined?	☑	Section 6
N	Plans for the site	☑	n/a
9. Key challenges			
O	The challenges (i.e. barriers or key risks) summarised	☑	Section 4
10. Approval of HDP			
	Paul Keenlyside, Lambeth Council	☑	Page 3

Numbers 1 to 10 are from the Salix HDP Quality Assuarance document and letters ‘a’ to ‘o’ are from the HDP guidance explanation

6.02 Data Collection: Energy Sources

Data Points	Sources	Tracker of Schools with Data Available
General	**General**	**General**
School Name	Get Information About Schools gov.uk website	72/72
School Unique Number (URN & UPRN)	Get Information About Schools gov.uk website	72/72
Postcode	Get Information About Schools gov.uk website	72/72
No. of Pupils	Get Information About Schools gov.uk website	69/72
% of Free School Meals	Get Information About Schools gov.uk website	69/72
Environment	**Environment**	**Environment**
Local Index of Deprivation	London Datastore gov.uk website	72/72
Air Quality - PM2.5	Firstplanit.com	72/72
Air Quality - PM10	Firstplanit.com	72/72
Air Quality - PM NO2	Firstplanit.com	72/72
Local Flood Risk	Firstplanit.com	72/72
Local Overheating Risk	Firstplanit.com	72/72
Listed Building on Site	Firstplanit.com	72/72
Conservation Area	Firstplanit.com	72/72
Engagement	**Engagement**	**Engagement**
Responded to RAFT Head Teacher Survey	RAFT	17/72
Responded to RAFT Premises Survey	RAFT	12/72
Attended Lambeth Premises Manager Training	RAFT	21/72
Part of the Future Fit Network of Schools	Lambeth Council Climate Change and Sustainability	9/72
Block Geometry	**Block Geometry**	**Block Geometry**
Block Name	Dept. for Education Condition Survey Collection 1	71/72
Building Storeys	Set of Prioritised Building Sources	72/72
Gross Internal Area	Set of Prioritised Building Sources	72/72
Ground Floor Internal Area	Set of Prioritised Building Sources	72/72
Perimeter	Set of Prioritised Building Sources	72/72

6.02 Data Collection: Energy Sources

Block Fabric	Block Fabric	Block Fabric
Building Age Archetype	Set of Prioritised Building Sources	72/72
Age Archetype of Major Extensions/ Refurbishment	Set of Prioritised Building Sources	72/72
Roof Pitch	Set of Prioritised Building Sources	72/72
Roof Construction Type	Set of Prioritised Building Sources	6/72
Roof Condition	Set of Prioritised Building Sources	71/72
Wall Construction Type	Set of Prioritised Building Sources	72/72
Wall Condition	Set of Prioritised Building Sources	72/72
Curtain Walling Area	Set of Prioritised Building Sources	72/72
Curtain Walling - Proportion Glazed	Set of Prioritised Building Sources	72/72
Glazing Type	Set of Prioritised Building Sources	69/72
Glazing Condition	Set of Prioritised Building Sources	67/72

Block Services	Block Services	Block Services
Existing Heat Network Connection	Set of Prioritised Building Sources	72/72
Air Conditioning	Set of Prioritised Building Sources	72/72
Lighting Type	Set of Prioritised Building Sources	69/72
Lighting Condition	Set of Prioritised Building Sources	69/72
PIR	Set of Prioritised Building Sources	68/72
ASHP	Set of Prioritised Building Sources	72/72
PV Panels	Set of Prioritised Building Sources	72/72
Ventilation System	Set of Prioritised Building Sources	1/72
Hot Water System Distribution	Set of Prioritised Building Sources	7/72
Hot Water System Fuel	Set of Prioritised Building Sources	37/72
Hot Water System Age	Set of Prioritised Building Sources	17/72
Hot Water System Controls	Set of Prioritised Building Sources	12/72
Space Heating System Fuel	Set of Prioritised Building Sources	63/72
Space Heating System Age	Set of Prioritised Building Sources	34/72
Space Heating System Controls	Set of Prioritised Building Sources	12/72
Kitchen Cooking Fuel	Set of Prioritised Building Sources	0/72
Kitchen Appliances Condition	Set of Prioritised Building Sources	0/72

6.02 Data Collection: Energy Sources

Energy Use	**Block Fabric**	**Block Fabric**
Gas use	Set of Prioritsed Energy Sources	67/72
Electricity Use	Set of Prioritsed Energy Sources	67/72
Meter Name (MPAN)	UKPN Records	61/72
Meter Type (Half Hourly or Non-Half Hourly)	UKPN Records	61/72
Ampage of Electrical Service Head	UKPN Records	61/72
Maximum Half-Hourly Load	UKPN Records for Half Hourly Meters	18/72
Planned Works	**Block Services**	**Block Services**
Planned ASHPs	Set of Prioritised Planned Works Sources	72/72
Planned LED	Set of Prioritised Planned Works Sources	72/72
Planned PV	Set of Prioritised Planned Works Sources	72/72
Planned Roof Insulation	Set of Prioritised Planned Works Sources	72/72
Planned Wall Insulation	Set of Prioritised Planned Works Sources	72/72
Thermal Performance	**Thermal Performance**	**Thermal Performance**
Archetype-based typical construction u-values	Set of Prioritised Thermal Performance Sources	72/72
Archetype-based typical window to wall ratio	Set of Prioritised Thermal Performance Sources	72/72
Archetype-based typical storey heights	Set of Prioritised Thermal Performance Sources	72/72
Post-retrofit u-values	Set of Prioritised Thermal Performance Sources	72/72

6.02 Data Collection: Energy Sources

Prioritised Building Sources
1) RAFT HDP Survey to Premises Managers
2) RAFT HDP Survey to Head Teachers
3) School Floor Plans provided by Lambeth Council
4) Google Earth
5) Lambeth Council Records of PSDS 1&2 Bids
6) Lambeth Council M&E Validation Survey Reports
7) Lambeth Council Records of Capital Works
8) ARUP Net Zero Feasibility Study
9) RE:FIT Investment Grade Audits
10) Lambeth Council Building Condition Surveys
11) DfE Condition Survey Collection 2 (CDC2)
10) DfE Condition Survey Collection 1 (CDC1)

Prioritised Energy Sources
1) Lambeth Gas and Electricity Bills
2) Display Energy Certificates
3) Lambeth School Energy Data
4) Carbon Trust Database

Prioritised Planned Works Sources
1) Lambeth School Capital Maintenance Programme 2023-27
2) Lambeth Council Records of PSDS 3b bids

Prioritised Thermal Performance Sources
1) Historic Part L & Part Building Regulations

Modern (1967-1976)	Part F 1965
Post-oil crisis (1977-2003)	Part L 1981
Schools for the Future (Post-2003)	Part L 2002

2) Duncan Grassie, Energy & Resources Dept, UCL
3) CIBSE Part A
4) Standard Assessment Procedure 10.2

Prioritised Building Sources
12/72
17/72
59/72
72/72
21/72
21/72
25/72
10/72
12/72
66/72
14/72
71/72

Prioritised Energy Sources 67/72
37/72
58/72
59/72
72/72

Prioritised Planned Works Sources
72/72
15/72

Prioritised Thermal Performance Sources
72/72

72/72
72/72
72/72

Prioritised Building Sources
All works planned to date have been completed
Longform text interpretations: 'mostly' = 66%, 'mixed'/'partial' = 50%
If LED or PIR coverage unknown, assumed partial
If school's existing gas EUI is less than 100kwH/m^2 all glazing assumed double glazed.
If glazing type unknown, assumed based on archetype
If condition unknown, assumed fair
Ventilation assumed passive (through windows)
For all schools, assumed that hot water is centrally heated and distributed by pipes
For all schools, assumed that kitchen cooking fuel is gas

Prioritised Energy Sources
Schools with no data assumed to have typical EUIs
Schools without MPAN numbers associated assumed to have average capacity and load from across the project
Schools with half-hourly meters assumed to have average electrical loads

Prioritised Planned Works Sources
Assumed that all works planned in 2023 will be completed

General
Schools across 2 sites have equal number of pupils on each site
Schools across 2 sites have equal number of pupils who are eligible for Free School Meals on each site

6.03 Modelling Assumptions

Volume	**Volume**	
Flat Roof Area Coefficient	100	% of floor area = roof area
Pitched Roof Area Coefficient	120	% of floor area = roof area
System Efficiency	**System Efficiency**	
Air source heat pump efficiency	270	% of energy input to energy output
Gas boiler efficiency		
<20 years old or unknown age	0.8	% of energy input to energy output
20-25 years old	0.75	% of energy input to energy output
>25 years old	0.6	% of energy input to energy output
Point of use hot water efficiency	0.8	% of energy input to energy output
Heat Energy	**Heat Energy**	
Annual Heating Degree Days	58	kKh/yr
Winter Internal Set Point	20	°C
Winter Outdoor Design Temperature	-2	°C
Heat Capacity of Air	0.33	Wh/m3K
Floor Heat Loss Reduction Factor	70	% of area considered to lose heat
Air Changes per Hour	0.7	
Ventilation Flow Rate	20	m^3/s
Single Glazing G-Value	0.9	W/m^2K
Double Glazing G-Value	0.8	W/m^2K
Operational Energy	**Operational Energy**	
Hot water demand	27	kWh/person/year
Ratio of pupils to Full Time Equivalent staff	1 : 0.16	
Minimum % of pupils who eat school meals	40	%
Existing gas usage per meal	0.29	kWh/meal
Electricity use in a gas fuelled kitchen	0.04	kWh/meal
Electricity use in an electricity fuelled kitchen	0.21	kWh/meal
No. of meals per year per person	195	
Electricity usage of LED lighting with PIR	4	kWh/m^2.year
Electricity usage of fluorescent lighting	8.4	kWh/m^2.year
Annual solar photovoltaic electricity generation	190	kWh/m^2
Potential reduction in operational gas use	10	%
Potential reduction in operational electricity use	10	%

6.03 Modelling Assumptions

Energy Cost

Cost per kWh Gas	0.107	£/kWh
Cost per kWh Electricity	0.302	£/kWh

Energy-Related Carbon Emissions

Carbon Factor Gas 2023	0.21364	$kgCO^2e/kWh$
Carbon Factor Electricity 2023	0.28813	$kgCO^2e/kWh$

Energy Intensity Benchmarks

National Typical School Gas Use Intensity	122	kWh/m^2.year
National Typical School Electricity Use Intensity	43	kWh/m^2.year
RAFT 'Pragmatic' Gas + Electricity Use Intensity	75	kWh/m^2.year
RAFT 'Ambitious' Gas + Electricity Use Intensity	65	kWh/m^2.year
Lambeth Median School Gas Use Intensity	112	kWh/m^2.year

6.04 Archetypes

Historic - pre 1919

With the 1870s Education Act the government took responsibility for the education of the nation's children. School boards were created in boroughs and parishes and run as public bodies until 1902. 'Board schools' were built where there was no alternative church or charity school leading to a wave of construction.

Board Schools are defined by large open halls where classes of more than 100 children could be taught in one room with smaller classrooms around the perimeter. The Act was particularly successful in London where over 400 new board schools were opened between 1870 and 1902.

Key Legislation

<u>Elementary Education Act 1870</u>
Set the framework for schooling of all children between the ages of 5 and 12 in England and Wales. It established school boards to organise educational provision and authorized public money to build and improve schools with attached conditions on the standards of education.

<u>Education Act 1902</u>
Established Local Education Authorities to replace the School Boards.

Assumptions

Wall	**Construction**	Solid masonry
Wall	**U-Value**	1.9 W/m²K
Wall	**Retrofit Potential**	Internal wall insulation
Wall	**Post-Retrofit U-Value**	0.4 W/m²K
Roof	**Construction**	Uninsulated timber truss
Roof	**U-Value**	2.3 W/m²K
Roof	**Retrofit Potential**	Mineral wool insulation
Roof	**Post-Retrofit U-Value**	0.15 W/m²K
Floor Construction		Suspended timber
Windows	**Type**	Single glazed
Windows	**U-Value**	5.7 W/m2K
Windows	**Retrofit Potential**	Triple glazed
Windows	**Post-Retrofit U-Value**	0.8 W/m²K
Windows	**Window to Wall Ratio**	25% Glazing
Typical Storey F-F Height		4.5 m
Envelope	**Infiltration**	10 ACH
Envelope	**Post-Retrofit Infiltration**	3 ACH

Typical Historic School

Richard Atkins Primary School, built 1897

Photo source: Historic England, David Martin (2017)

6.04 Archetypes

Inter-war (1920-1944)

Despite a population increase few schools were built in the interwar period due to the economic depression and a lack of direction from central government. A short lived peak in building came in the late-1930s. Buildings from this era have traditional masonry structures and smaller rooms organised along corridors and large windows.

Key Legislation

Hadow Report 1926
Reports by the Consultative Committee of the Board of Education separated primary education into infant school (5-7) and junior school (7-11) and recommended smaller class sizes of under 30.

Education Act 1936
Increased school leaving age to 15. Eased funding by offering building grants of up to 75 per cent for new ‘Special Agreement’ schools and led to a short-lived school building peak.

Physical Training and Recreation Act 1937
Extended the powers of local authorities relating to the provision of facilities for sports and leisure activities. Sports halls and playgrounds became important facilities provided by schools.

Assumptions

Wall	**Construction**	Solid Masonry
	U-Value	1.9 W/m²K
	Retrofit Potential	Internal wall insulation
	Post-Retrofit U-Value	0.4 W/m²K
Roof	**Construction**	Uninsulated timber truss
	U-Value	2.3 W/m²K
	Retrofit Potential	Mineral wool insulation
	Post-Retrofit U-Value	0.15 W/m²K
Floor Construction		Suspended timber
Windows	**Type**	Single glazed
	U-Value	5.7 W/m2K
	Retrofit Potential	Triple glazed
	Post-Retrofit U-Value	0.8 W/m²K
	Window to Wall Ratio	27% Glazing
Typical Storey F-F Height		3.5 m
Envelope	**Infiltration**	10 ACH
	Post-Retrofit Infiltration	3 ACH

Typical Inter-war School

La Retraite Roman Catholic Girls' School, built 1935

Photo source: WIkipedia Commons, Noel Foster (2005)

Post-war (1945-1966)

A large number of schools were built during this period due to war-damage and the population boom, however there was also a chronic shortage of building materials.

Between 1945 & 1950, the HORSA building programme provided prefabricated 'hut'-style accommodation to meet the postwar additional educational demand.

The CLASP (Consortium of Local Authorities Special Programme) in the 1950s rolled out open plan schools, many with lightweight, prefabricated and standardised construction.

Key Legislation

Education Act 1944
Set the structure of the post-war system of state education in England and Wales. Local Education Authorities were made responsible for providing primary and secondary schools. Planning for school sites was based on immediate and prospective need. Schools were to provide many ancillary services including medical treatment, meals, boarding, clothes, facilities for social and physical training, and transport. The Act also prohibited school fees in schools maintained by local education authorities, ending secondary school fees.

Assumptions

Wall	**Construction**	Masonry with uninsulated cavity or curtain walls
	U-Value	1.7 W/m²K / 3.4 W/m²K
	Retrofit Potential	Blown glasswool cavity wall insulation
	Post-Retrofit U-Value	0.25 W/m²K / 2.0 W/m²K
Roof	**Construction**	Uninsulated steel truss or concrete deck
	U-Value	2.3 W/m²K / 2.3 W/m²K
	Retrofit Potential	Mineral wool or rigid foam insulation
	Post-Retrofit U-Value	0.15 W/m²K / 0.29 W/m²K
Floor Construction		Concrete slab
Windows	**Type**	Single glazed
	U-Value	5.7 W/m²K
	Retrofit Potential	Triple glazed
	Post-Retrofit U-Value	0.8 W/m²K
	Window to Wall Ratio	25%
Typical Storey F-F Height		2.7 m
Envelope	**Infiltration**	10 ACH
	Post-Retrofit Infiltration	3 ACH

Typical Post-war School

Bishop Thomas Grant Roman Catholic School, built 1959

Photo source: Teach Lambeth

Modern (1967-1976)

Between 1965 and 1970, the old Tripartite system (Grammar, Secondary Technical and Secondary Modern schools) was replaced with Comprehensive Schools (although some Grammar Schools remained). Comprehensive School buildings needed to accommodate a wider range of students and subjects such as workshops and gymnasiums.

The minimum school leaving age was raised to 16 in 1972. Extra blocks were often built to cope with the extra year-group of students. ROSLA Blocks (Raising of School Leaving Age), were often pre-fabricated portable classrooms planned as temporary solutions.

Key Legislation

Circular 10/65 1965
Initiated the change from the Tripartite system to Comprehensive Schools.

Raising of the School Leaving Age Order 1972
Changed the minimum school leaving age from 15 to 16.

Part F Thermal Insulation 1965
Introduced in 1965, Part F put minimum limits on the thermal resistance of walls, floors, roofs and windows for the first time.

Assumptions

Wall	**Construction**	Masonry with uninsulated cavity or curtain walls
	U-Value	1.7 W/m²K / 3.4 W/m²K
	Retrofit Potential	Blown glasswool cavity wall insulation
	Post-Retrofit U-Value	0.25 W/m²K / 2.0 W/m²K
Roof	**Construction**	Uninsulated steel truss or concrete deck
	U-Value	1.4 W/m²K / 1.4 W/m²K
	Retrofit Potential	Mineral wool or rigid foam insulation
	Post-Retrofit U-Value	0.15 W/m²K / 0.29 W/m²K
Floor Construction		Concrete slab
Windows	**Type**	Single glazed
	U-Value	5.7 W/m²K
	Retrofit Potential	Triple glazed
	Post-Retrofit U-Value	0.8 W/m²K
	Window to Wall Ratio	25%
Typical Storey F-F Height		3.2 m
Envelope	**Infiltration**	10 ACH
	Post-Retrofit Infiltration	5 ACH

Typical Modern School

Herbert Morrison Primary School, built 1972

Photo source: London Picture Archive (1972)

6.04 Archetypes

Post-oil crisis (1977-2003)

The Education Reform Act of 1988 aimed to create a 'market' in education. It introduced the National Curriculum, Key Stage Examinations, School Ratings and Formula Funding (funding based on no. of children that could be attracted to the school).

Following the 1970's Oil Crises, the Building Regulations introduced stricter thermal resistance minimums to conserve energy. In the 1970s, the minimum was achievable with a 50mm uninsulated cavity walls. In the 1980s, a reduced minimum made aerated blockwork standard for the inner leaf of cavity walls. In the 1990s, cavity wall insulation became standard. In 1995, the limit for windows could only be achieved by double glazing.

Key Legislation

<u>Education Reform Act 1988</u>
Introduced a range of policies (eg. Key Stage Exams and Formula Funding). Some schools became funded 'Grant Maintained Schools'.

<u>Part F Thermal Insulation / Part L Conservation of Fuel and Power</u>
Revised in 1976, 1985, 1990. We have used the 1985 version to determine minimum building fabric u-values for the period.

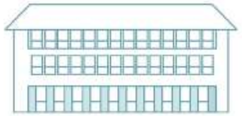
Assumptions

Wall	**Construction**	Masonry with partially insulated cavity or curtain walls
	U-Value	0.6 W/m²K / 2.4 W/m²K
	Retrofit Potential	Risk of thermal bypass*
	Post-Retrofit U-Value	N/A
Roof	**Construction**	Insulated steel truss or concrete deck
	U-Value	0.6 W/m²K / 0.6 W/m²K
	Retrofit Potential	Mineral wool or rigid foam insulation
	Post-Retrofit U-Value	0.15 W/m²K / 0.29 W/m²K
Floor Construction		Concrete slab
Windows	**Type**	Double glazed
	U-Value	2.2 W/m²K
	Retrofit Potential	Triple glazed
	Post-Retrofit U-Value	0.8 W/m²K
	Window to Wall Ratio	27%
Typical Storey F-F Height		3.5 m
Envelope	**Infiltration**	10 ACH
	Post-Retrofit Infiltration	5 ACH

Typical Post-Oil Crisis School

St. Mary's Roman Catholic Primary School, built 1993

Photo source: Teach Lambeth



6.04 Archetypes

21st Century (post 2003)

After 2003, class sizes were capped at 30 students for 5-7 year olds. In 2013, The School Leaving Age was raised to eighteen. Children could choose to attend Part-Time Sixth Form Colleges or Vocational Apprenticeships.

Key Legislation

Asbestos Prohibition Regulations 1999
The Regulation prohibited the import and use of asbestos in all forms in building work.

Education and Skills Act 2008
Raised the minimum school/training leaving age from 16 to 18.

Building Schools for the Future Programme 2005 & Primary Capital Programme 2007
Government investment programmes in school buildings in England. When the programme ended, 409 schools had been rebuilt or refurbished.

The Priority Schools Building Programme 2011
Established to address the needs of those schools that remained in the worst condition.

Part L Conservation of Fuel and Power
Revised in 2002, 2006, 2010, 2016 and 2021. We have used the 2002 version to determine minimum building fabric u-values for the period.

Assumptions

Wall	**Construction**	Masonry with insulated cavity or curtain walls
	U-Value	0.35 W/m^2K / 2.0 W/m^2K
	Retrofit Potential	Not cost effective
	Post-Retrofit U-Value	N/A
Roof	**Construction**	Insulated steel truss or concrete deck
	U-Value	0.25 W/m^2K / 0.16 W/m^2K
	Retrofit Potential	Not cost effective
	Post-Retrofit U-Value	N/A
Floor Construction		Insulated concrete slab
Windows	**Type**	Double glazed
	U-Value	2.0 W/m^2K
	Retrofit Potential	Triple glazed
	Post-Retrofit U-Value	0.8 W/m^2K
	Window to Wall Ratio	25%
Typical Storey F-F Height		3.3 m
Envelope	**Infiltration**	8 ACH
	Retrofit Potential	Not cost effective

Typical 21st Century School

Paxton Primary School, built 2017

Photo source: West Norwood News

6.05 Capital costs - methodology

Estimating costs

The cost estimation process has been carried out jointly by RAFT and the Quantity Surveyors Doig + Smith. The costings over the following pages include:

Construction costs based on:
• BCIS (Building Cost Information Service) industry standard cost plan structure.
• Measured work rates based on competitive tender returns.
These are inclusive of Main Contractor's overheads and profit.

Contractor Costs/Preliminaries (20%) including site staff, accommodation and power.

Development Costs allowances covering:
• Consultant's Fees (12%)
• Digital Survey Fees
• Contractor Pre-construction Fees (1.5%)
• Contractor Design Fees (1.5%)

Risk allowances covering:
• Design Development (10%)
• Construction (10%)
• Employer Change e.g. Changes in Scope of Work or Brief (10%)
• Employer Other e.g. Liquidated Damages (10%)

Exclusions

The following items have been excluded from the cost estimates as they currently cannot be clearly defined:

- Any works in relation to the removal of contaminated land
- Any works in relation to removal of asbestos
- Any works in relation to timber rot / infestation
- Any FFE other than that shown in the Cost Plan
- Any structural works
- Cost of school decanting
- Legal fees
- Insurances
- Finance Charges
- VAT
- Asbestos surveys
- Inflation

In addition, the following further assumptions have been made:
• No sites have poor soil conditions
• All existing utilities infrastructures are capable of providing required capacities
• All works undertaken with unrestricted access / egress and during normal working hours

Anticipated Risks

The following risks have been identified to date for the Project:
• Unknown conditions discovered during works
• Phasing logistics of work being carried out during building operation
• Inflation (see appendix)

6.06 Capital costs - estimates

Package 1 TOTAL	**£44,800,000**
LED	£17,700,000
PV	£2,500,000
POU	£1,600,000
Electric Kitchen	£3,900,000
Package 1 Construction Total	**£25,600,000**
Development Costs	£3,900,00
Risk Allowances	£10,300,000
Contractor Costs	£5,200,000

Package 2 TOTAL	**£52,800,000**
Uninsulated cavity walls	£18,100,000
Uninsulated roofs	£1,200,000
Single glazing	£11,000,000
Package 2 Construction Total	**£30,200,000**
Development Costs	£4,600,00
Risk Allowances	£12,100,000
Contractor Costs	£6,100,000

Package 3 TOTAL	**£99,200,000**
ASHP	£38,400,000
New radiators	£6,700,000
Removal of old pipes	£6,100,000
BMS	£7,300,000
Package 3 Construction Total	**£54,400,000**
Development Costs	£8,200,00
Risk Allowances	£21,800,000
Contractor Costs	£10,900,000

Packages 1,2,3 TOTAL	**£194,000,000**
LED	£17,700,000
PV	£2,500,000
POU	£1,600,000
Electric Kitchen	£3,900,000
Uninsulated cavity walls	£18,100,000
Uninsulated roofs	£1,200,000
Single glazing	£11,000,000
ASHP	£35,200,000
New radiators	£6,700,000
Removal of old pipes	£6,100,000
BMS	£7,300,000
Package 1,2,3 Construction	**£110,900,000**
Development Costs	£16,700,00
Risk Allowances	£44,400,000
Contractor Costs	£22,200,000

Package 4 TOTAL	**£285,100,000**
LED	£17,700,000
PV	£2,500,000
POU	£1,600,000
Electric Kitchen	£3,900,000
Uninsulated cavity walls	£18,100,000
Single glazing	£11,000,000
ASHP	£27,200,000
New radiators	£6,700,000
Removal of old pipes	£6,100,000
BMS	£7,300,000
Roof insulation	£36,100,000
Poor condition double glazing	£1,100,000
MVHR	£24,300,000
Package 4 Construction Total	**£162,900,000**

Package 4	
Development Costs	£24,500,00
Risk Allowances	£65,200,000
Contractor Costs	£32,600,000

Package 5 TOTAL	**£396,100,000**
LED	£17,700,000
PV	£2,500,000
POU	£1,600,000
Electric Kitchen	£3,900,000
ASHP	£20,900,000
New radiators	£6,700,000
Removal of old pipes	£6,100,000
BMS	£7,300,000
Roof insulation	£36,100,000
MVHR	£24,300,000
All Glazing	£39,300,000
Wall Insulation	£35,400,000
Curtain Walling	£25,200,000
Package 5 Construction Total	**£226,400,000**
Development Costs	£34,000,00
Risk Allowances	£90,600,000
Contractor Costs	£45,300,000

6.07 Capital costs - schedule of rates

1	**Package 1**		
1.1	LED & PIR		
	Remove existing light fittings	m2	£6
	Replace existing light fittings with LED luminaires	m2	£75
	Install lighting control system complete including wiring	m2	£50
	Electric wiring, controls etc.	m2	£40
1.2	POU		
	Decommission & remove existing hot water distribution system	item	£7,500
	Hot water instantaneous point of use heater	nr	£2,000
1.3	PV		
	Allowance for installation of PV panels on roof	m2	£250

Package 1 Assumptions

1.2 POU

WC numbers assumed according to DfE Employer's Requirements. Assumed at least 3 POU for WC's plus number of WC no/5 + basin in every classroom (pupils/30) + 1 for staffroom + 1 for kitchen

2	**Package 2**		
2.1	Cavity wall insulation		
	Cavity wall insulation, EPS polystyrene beads; 50 thick cavity	m2	£200
	extra over for; cavity preparation	m2	£80
2.2	Roof insulation		
	Solid mineral / glass wool board insulation; vcl; 300 thick on roof	m2	£115
2.3	Triple glazing		
	New triple glazed windows, rooflights and doors	m2	£1,110
	extra over for; aluminium external clad	m2	£60

Package 2 Assumptions

2.1 Cavity wall insulation

Walls built 1945-1977 assumed to be uninsulated cavities

2.2 Roof insulation

10% roofs built pre-2003 assumed uninsulated. Cost distributed across relevant blocks.

2.3 Triple glazing

Single glazing only replaced

6.07 Capital costs - schedule of rates

3	**Package 3**		
3.1	ASHP		
	Remove existing gas boiler	nr	£1,500
	Replace boilers for ASHPs (36kVA output array)	nr	£55,000
3.2	New Emitters		
	Decommission & remove existing hot water distribution system	m2	£10
	New distribution pipework	m2	£15
	Replace heat emitters	nr	£750
3.3	BMS		
	Install Building Management System	m2	£30

Package 3 Assumptions

3.2 2 no. Radiators required/55sqm

ASHPs sized to reduced peak heat loads associated with fabric upgrades if Package 2 works carried out in tandem (P1,2,3 combined)

6.07 Capital costs - schedule of rates

4 Package 4

4.1.1	Pitched/Good - Roof repairs and insulation		
	Pitched roof repairs; minor repairs to tiles; under felt	m2	£135
	Solid mineral / glass wool board insulation; vcl; 300 thick on roof	m2	£115
	12.5mm thick plasterboard; taped and filled joints	m2	£64
	extra over for; access scaffolding	m2	£55
4.1.2	Pitched/Bad - Roof covering replacement and insulation		
	Remove existing roof covering; tiles / slates and under felt	m2	£55
	Pitched roof replacement; roof tiling replacement; under felt	m2	£162
	Solid mineral / glass wool board insulation; vcl; 300 thick on roof	m2	£115
	12.5mm thick plasterboard; taped and filled joints	m2	£64
	extra over for; access scaffolding	m2	£55
4.1.3	Flat/Good - Roof repairs and insulation		
	Flat roof minor repairs; single ply membrane to top of roof	m2	£97
	Rockwool Hardrock or similar insulation between joists; 150 thick, vcl	m2	£121
	extra over for; access scaffolding	m2	£55
4.1.4	Flat/Bad - Roof covering replacement and insulation		
	Remove existing roof covering; membrane roof and insulation	m2	£50
	Flat roof replacement; new single ply membrane; to top of roof	m2	£135
	Solid mineral / glass wool board insulation; vcl; 200 thick on roof	m2	£113
	extra over for; access scaffolding	m2	£55
4.2	MVHR		
	Supply and install mechanical ventilation system with high efficiency heat recovery	m2	£100
4.3	Triple glazing		
	New triple glazed windows, roof lights and doors	m2	£1,110
	extra over for; aluminium external clad	m2	£60

Package 4 Assumptions

4.2 MVHR assumed to be required throughout all blocks following retrofit works

4.3 Triple glazing to all single glazing and double glazing in poor condition

ASHPs sized to reduced peak heat loads associated with fabric upgrades.

6.07 Capital costs - schedule of rates

5 Package 5

5.1.1	Internal Wall Insulation (if partial wall insulation is in poor condition)		
	Temporary relocation / diversion of pipes, electrical cable etc.	m2	£50
	Relocating furniture, radiators, light fittings etc.; allowance	m2	£47
	Remove and replace skirting boards; allowance	m2	£44
	Int. wall insulation; 80 thick wood fibre boards, mech. fixings	m2	£193
	extra over for; 10 thick Aerogel window reveal insulation (25%)	m2	£35
	Lime plaster; 15 thick	m2	£66
	Rectifying finishes, joinery etc.; allowance	m2	£25
5.1.2	Cavity + External Wall Insulation		
	Cavity wall insulation, EPS polystyrene beads; 50 thick cavity	m2	£200
	extra over for; cavity preparation	m2	£80
	Render finish to external walls	m2	£94
	Extend eaves around perimeter; including removing existing	m	£500
	Extend verges around perimeter; including removing existing	m	£500
	extra over for; access scaffolding	m2	£55
5.1.3	Curtain walling		
	New triple glazed windows and doors, new insulated panels	m2	£1,110
	extra over for; aluminium external clad	m2	£60
	extra over for; access scaffolding	m2	£55
5.1.4	Repointing		
	Repointing; raggling out loose / defective mortar	m2	£95
	extra over for; access scaffolding	m2	£55
5.2	Triple glazing		
	New triple glazed windows, roof lights and doors	m2	£1,110
	extra over for; aluminium external clad	m2	£60

Package 5 Assumptions

5.2 Triple glazing to all single and double glazing

ASHPs sized to reduced peak heat loads associated with fabric upgrades.

6.07 Capital costs - schedule of rates

6	**Development Costs**		
6.1	Digital Surveys		
	Primary schools	m2	£4
	Secondary schools	m2	£2
6.2	Consultants Fees		12%
6.3	Contractor Pre-Construction Fees		1.50%
6.4	Contractor Design Fees		1.50%
7	**Project Risks**		
7.1	Design Development Risk		10%
7.2	Construction Risk		10%
7.3	Scope Change Risk		10%
7.4	Employer Cost Risk		10%

Inflation (Excluded)

"In the past few years, we have witnessed some major international and national events that have had and are still having a major impact on the construction market in the United Kingdom.
The aftermath of the Great Recession from 2007 to 2009 resulted in historically low central bank base rates which stimulated borrowing and pushed the economy in an upwards direction. Despite this, the rate of inflation stayed low averaging 1.7% between 2011 and 2021, when post-COVID pent up market demand started to push the rate up. The rate of inflation has been further affected by global supply chain issues largely caused by China's zero COVID strategy and the war in Ukraine. Energy, material, labour and commodities costs are all playing a part in increasing inflation rates over that past few months. However, it is anticipated that some of these upward pressures will begin to ease, and we have seen some early signs of this in some areas."
Doig + Smith

6.08 References

NOTE: The Department for Business Energy & Industrial Strategy (BEIS) is now known as the Department for Energy Security & Net Zero (DESNZ)

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7.0 Glossary

An alphabetical list of all terms and abbreviations used in this report.

MVHR at Downderry Primary School in Lewisham

"Ultimately, Net Zero will mean gradually, but completely, moving away from burning fossil fuels for heating."

HM Government, Heat & Buildings Strategy, 2021

RAFT Retrofit Action for Tomorrow

7.01 Glossary

Term	Abbreviation	Definition
Action Ready		Ready to take all relevant actions, as soon as action is possible.
Air Source Heat Pump	ASHP	A heat pump that extracts heat from the air (it is able to do this as outside air is above absolute zero).
Air-to-Air Heat Pump	A2A	An ASHP that transfers heat to air.
Air-to-water Heat Pump	A2W	An air source heat pump that transfers heat to water (for use as hot water or in radiators).
Amps		An amp or ampere is a unit of electrical current, and is the rate of flow of electricity.
Bivalent System		A system that combines a heat pump and fossil fuel boiler for heating and hot water. This is sometimes referred to as a hybrid system.
Boiler Efficiency		A metric that compares the boiler's heat output with the energy it used to create that heat, given as a percentage.
Building Management System	BMS	A computer-based system used to monitor and manage building services such as ventilation and heating.
Carbon Cost Threshold (CCT)	CCT	The maximum cost per tonne of direct carbon saved over the lifetime of the measure funded, used as an eligibility threshold for PSDS funding.
Carbon Dioxide	CO_2	The most prevalent greenhouse gas.
Carbon Dioxide Equivalent	CO_2e	A metric indicating the global warming effect of the mass of GHGs in terms of the equivalent mass of CO_2 measured in tonnes or kg of gas emitted.
Carbon Factors		A factor applied to energy that is consumed by buildings to understand the carbon emissions associated with this amount used. It includes the carbon used to produce and deliver the energy used within the building.
Cavity Wall Insulation	CWI	Wall insulation is present in the gap between two layers of an external wall. This can be as-existing or a retrofit measure.
Coefficient of Performance	COP	The COP of a heat pump is a measure of its efficiency. It is the ratio of useful heating/cooling energy provided against energy required. A higher COP signifies a higher efficiency.
Deep Retrofit		The retrofitting of a building, aiming to improve the performance of the building to reach long-term low energy goals.
Department for Business, Energy and Industrial Strategy	BEIS	Government department that initiated both the PSDS and PCSF grants. They are administered by Salix Finance. BEIS has now become the Department for Energy Security and Net-Zero.
Display Energy Certificate	DEC	A certificate displaying the energy performance of public buildings, rated from A (very efficient) to G (inefficient).
Distribution Network Operator	DNO	An electricity grid operator, there are fourteen across the UK.
Embodied Carbon		The CO_2e associated with the production, assembly, use, maintenance and disposal of a product or building. It is evaluated by life cycle carbon assessment.
Energy Demand		The rate at which energy is required measured as kilowatts (kW).
Energy Performance Certificate	EPC	An prediction of building energy efficiency, rated from A (very efficient) to G (inefficient).
Energy Use		The total amount of energy consumed over a period of time e.g. kilowatt hours per year (kWh/a).
Energy Use Intensity		The total amount of energy used in a building over a year per meter squared of floor area (GIA), measured in kWh/m²a.
External Wall Insulation	EWI	A retrofit measure where wall insulation is fitted to the outside of the building.

7.01 Glossary

Term	Abbreviation	Definition
Funding-ready		Ready to identify relevant funding or collaborate to develop funding. Understanding your heating buildings, planning your actions, and having information to hand to determine eligibility and act rapidly on funding applications.
General Electricity demand		The amount of electricity consumed at the meter, used for everything except heating and hot water of a building.
Greenhouse Gas	GHG	A gas that contributes to global heating by trapping heat in the atmosphere.
Gross Internal Area	GIA	The whole enclosed area of a building within the external walls taking each floor into account and excluding the thickness of the external walls.
Ground Source Heat Pump	GSHP	A heat pump that extracts heat from the earth via pipes that are buried in the ground.
Heat Decarbonisation Plan	HDP	A plan for reducing or removing greenhouse gas emissions by replacing fossil fuel heating systems with low carbon alternatives and a 'whole building approach'.
Heat Load	HL	The power required to maintain a comfortable indoor temperature when the outside temperature is at its lowest, measured in W/m2. This is sometimes referred to as 'heating load'.
Heat Loss Form Factor	HLFF	The ratio of the external surface area (thermal envelope) to the heated floor area. A low ratio indicates a more efficient form.
Heat Pump		A machine that transfers heat from the air or ground to a building's heating system. For every one unit of electrical energy put in it can extract around two to four units of heat energy.
Hot Water Demand		The amount of water consumed at the meter to support a building's hot water needs.
Immediate Action		The wide range of potential actions which your school can consider acting on straight away, while developing your plans and organising funding for major capital works.
Incoming Electrical Capacity		The maximum power that a building is able to draw from the electricity grid, determined by a combination of constraints within the building, the link to grid or the local grid itself.
Internal Wall Insulation	IWI	A retrofit measure where wall insulation is fitted to the inside face of the exterior walls.
Kilowatt Hour	kWh	A unit of energy equal to one kilowatt (kW) of power sustained for one hour. This is the standard unit for measuring energy usage.
Light-emitting Diode	LED	A low energy lighting technology.
Local Network Demands		Is the increased pressure placed on a DNO by the added electrical loading of appliances, such as, heat pumps and solar panels.
Long Term Works		Major building works requiring significant capital investment, may include full windows upgrade, solid wall insulation and other major building works.
Low Carbon Skills Fund	LCSF	A grant fund available to public sector organisations to put in place a heat decarbonisation on their estate.
Lumen		The total amount of light emitted in all directions. This is a standard unit for measuring luminous flux.
Lux		The total amount of light that falls on a surface. This is a standard unit of measuring illuminance.
Mechanical Ventilation with Heat Recovery	MVHR	A ventilation system that pre-warms fresh air it using the heat of the outgoing air, thereby wasting less heat (and has less losses) than with more traditional ventilation.

7.01 Glossary

Term	Abbreviation	Definition
Medium Term Works		Minor works or individual measures incurring maintenance or capital cost, but which either qualify within existing school capital funding and/or a relatively short payback period.
Net Zero Operational Carbon		All operational energy consumption is met by on & off site renewables. (the amount which should be met with on-site renewables has not yet been defined).
Peak Electrical Load		Peak load is the maximum power that a building draws from the grid during its operations. The incoming electrical capacity should be 20% larger than the peak load.
Persistence Factor		The anticipated lifetime of an energy efficiency technology used to calculate lifetime savings for PSDS applications.
Public Sector Decarbonisation Scheme	PSDS	The Public Sector Decarbonisation Scheme provides grants for public sector bodies to fund heat decarbonisation and energy efficiency measures.
Retrofit		The use of new materials, products, and technologies in an existing building in order to lower its operational energy.
Retrofit-ready		Being in a position to commence retrofit works having a complete HDP, a detailed design and all building fabric defects having been rectified or repaired.
Routemap		The Church of England's Routemap to Net Zero Carbon by 2030.
Scope		An emission category defined by the Greenhouse Gas Protocol to understand where emissions are originating.
Scope 1		Direct emissions on site from combustion of fuels like oil and gas.
Scope 2		Indirect emissions from the generation of electricity off site.
Scope 3		Indirect emissions from sources that the organisation does not own or control, for example from purchasing of goods and services, waste, water use and travel.
Seasonal Coefficient of Performance	sCOP	A measure of how efficient a heat pump is over a year. A higher value is indicative of better performance. This is also known as Seasonal Performance Factor (SPF).
Short Term Works		Simple low-cost actions affordable within existing budgets, also called 'Easy Wins', 'Quick Wins', 'Low-hanging fruit'.
Single Phase Power		The type of electricity supply that most domestic properties in the UK use. It uses a single phase of alternating current (that fluctuates between negative and positive).
Solar Energy		The radiant energy received from the sun.
Solar Photo-voltaic	PV	A solar panel to generate renewable electrical energy.
Solar thermal		A technology that converts the radiant energy from the sun into hot water, often using dark pipes of water mounted on a south facing roof.
Space Heating Demand	SHD	The amount of energy per m2 which is needed to maintain a comfortable internal temperature over an average year, measured in kWh/m2a.
System efficiency		The proportion of energy that reaches the end user compared with the amount of energy required to generate it, taking the 'system losses' into account, given as percentage.

7.01 Glossary

Term	Abbreviation	Definition
System Losses		The energy lost through creation and distribution through a system. E.g. A condensing boiler with 80% efficiency generates hot water which reaches the tap cooler than it left the boiler due to heat loss through the pipework.
Three Phase Power		The type of supply more likely to be used by schools and commercial buildings. It uses three offset phases which should be balanced. Individual phases can be used in different zones of a building, or as required by machinery that uses three phases at once.
Treated Floor Area	TFA	The floor area of a building that will be heated according to Passivhaus methodology.
UK Power Networks	UKPN	The DNO that operates across London and the South East.
U-Value	U	The rate of transfer of heat through a material (watts per square metre-kelvin), typically through the fabric of a building (e.g. roof, walls and windows). A lower U-value gives better performance.
VA / Voluntary Aided School		A local-authority-maintained school that often, but not always, have a religious character. They are run by a responsible body, often a Church of England Diocesan Board of Education.
Volts	V	Voltage can be thought of as the electric pressure, similar to visualising water pressure in a pipe.
Watt	W	A watt is a measure of power, in this document relating either to heat or electrical power. In electrical terms, one watt is a volt multiplied by an amp.
Whole Life Carbon	WLC	This is the cradle-to-grave impact of a product or system, including the embodied and operational carbon. Assessing WLC helps to reach the lowest carbon emissions over its entire life, normally defined as a 60 year period.
Whole-building Retrofit		All factors that contribute to a building's performance are looked at holistically. This helps make sure combined measures to work well and reduces unintended consequences.

Limitations

This study has been carried out to look at the potential for energy and carbon savings only. Full survey, feasibility and detail design work would need to be carried out and statutory and other requirements met before comencing any works on site.

For further information
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